

## Appendix E - Tender Package Specifications



# **NRPS NG911 BACKUP CENTRE**

Welland, Ontario

Issued for Tender  
Project No: 60686829  
Jan. 2025

## **PROJECT MANUAL**

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1.1 **GENERAL – INFORMATION AVAILABLE TO BIDDERS**

- .1 Investigation data and reports were prepared for use in design and are furnished in good faith to bidders for information. The reports do not cover all conditions of the site or other localized conditions. Be satisfied regarding all matters relating to these reports and site conditions which may affect methods or cost of construction before commencing Work.
- .2 Neither the Owner nor the Consultant guaranty the accuracy or completeness of these reports. The Owner and the Consultant assume no responsibility for any interpretation or deduction that the bidders may make from these reports.

1.2 **GEOTECHNICAL INVESTIGATION REPORT**

- .1 A copy of the geotechnical investigation report titled GEOTECHNICAL INVESTIGATION, PROPOSED SINGLE STOREY INSTITUTIONAL BUILDING, 5 LINCOLN STREET, WELLAND, ONTARIO, prepared by Niagara Testing & Inspection Ltd., dated October 26, 2022, is appended to this Section.
- .2 The geotechnical investigation report was prepared for use in design and furnished in good faith to bidder for information. The report does not cover all conditions of the site or other localized conditions. Be satisfied regarding all matters relating to the report and site conditions which may affect methods or cost of construction before commencing Work.
- .3 Neither the Owner nor the Consultant guaranty the accuracy or completeness of this report. The Owner and the Consultant assume no responsibility for any interpretation or deduction that the bidder may make from this report.

1.3 **INVESTIGATION DATA AND REPORTS**

- .1 Investigation data and report (Reports) were prepared for use in design and are furnished in good faith for the information of the Contractor. The Report do not cover all conditions of the site or other localized conditions. Be satisfied with regard to all matters relating to these Reports and site conditions which may affect methods or cost of construction before commencing work.
- .2 Neither the Owner nor the Consultant guarantee the accuracy or completeness of the Reports. The Owner and the Consultant assume no responsibility for any interpretation or deduction that the Contractor may make from these Reports.
- .3 A copy of the following Reports is appended to this Section.
  - .1 Excess Soil Management Report. Proposed Single Storey Institutional Building. 5 Lincoln Street, Welland, Ontario.
  - .2 Niagara Regional Police Service. Network Cabling Specifications

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. This Section specifies the administrative and procedural requirements governing Allowances.
2. Type of Allowances include the following:
  1. Cash Allowances.
  2. Contingency Allowances.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 DEFINITIONS**

1. Cash Allowance: The words "PC Sum", "Prime Cost Sum", or "Expenditure Allowance" will be synonymous with the Term "Cash Allowance".
2. Contingency Allowance: Lump sum amounts for unforeseen services, products, or materials in addition to those specified.

### **1.4 SUBMITTALS**

1. Submit proposals for purchase of products or systems included in Allowances, in the form specified for Change Orders.
2. Submit invoices or delivery slips to show actual quantities of materials delivered to site for use in fulfillment of each Allowance.

### **1.5 ADMINISTRATION**

1. Each Allowance will be adjusted to actual cost as defined below and Change Order will amend Contract Price.
2. Progress payments for Work and material authorized under Allowances will be made in accordance with contract terms of payment.

### **1.6 CASH ALLOWANCE**

1. Cash Allowances are lump sum amounts for materials, or materials and installation where quantity, quality, or design information is not known prior to Contract signing, and to cover costs for quality control, inspection, and testing.
2. Use Cash Allowance only as directed by Consultant for Owner's purposes, and only by Change Orders that indicate amounts to be charged to Allowance.
3. Materials Only: Change Orders authorizing use of funds from Cash Allowance for purchase of materials only shall include and provide payment for:
  1. Net cost of material.
  2. Applicable duties and taxes.
  3. Delivery to site.
  4. The following items do not form a part of Cash Allowance for purchase of materials, and shall be accounted for as a part of Contract Sum:
    1. Handling at site, including unloading, un-crating, storage and hoisting.
    2. Protection from damage by elements or otherwise.
    3. Labour for installation and finishing.
    4. Other expenses required to complete installation.
    5. Overhead and profit.
4. Materials and Installation: Change Orders authorizing use of funds from Cash Allowance for purchase of materials and installation shall include and provide payment for:

1. Net cost of material.
2. Applicable duties and taxes.
3. Delivery to site.
4. Handling at site, including unloading, un-crating, storage and hoisting.
5. Protection from damage by elements or otherwise.
6. Labour for installation and finishing.
7. Other expenses required to complete installation.
8. The following items do not form a part of Cash Allowance for purchase of materials and installation, and shall be accounted for as a part of Contract Sum:
  1. Overhead and profit.
5. Testing and Inspection: Change Orders authorizing use of funds from Cash Allowance for testing and inspections shall include and provide payment for:
  1. Cost of engaging testing agencies.
  2. Actual tests and inspections.
  3. Reporting of results.
  4. The following items do not form a part of Cash Allowance for testing and inspections.
  5. Incidental labour by Contractor required to assist testing agency.
    1. Costs for retesting if previous tests and inspections result in failure.
    2. Contractor will account for their incidental labour costs as a part of Contract Price.
6. Costs of services not required by Contract Documents are not included in Cash Allowance.
7. Credit unused amounts remaining in Cash Allowance to Owner by Change Order at Project closeout.

## **2 Products**

### **2.1 PRODUCTS AND SYSTEMS**

1. At earliest practical date after award of Contract, advise Consultant of date when final selection and purchase of each product or system described by an Allowance must be completed to avoid delaying Work.
2. At Consultant's request, obtain proposals for each Allowance for use in making final selections. Include recommendations that are relevant to performing Work.
3. Purchase products and systems selected by Consultant from designated supplier.

## **3 Execution**

### **3.1 EXAMINATION**

1. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

### **3.2 PREPARATION**

1. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related Work.

### 3.3 SCHEDULE OF ALLOWANCES

1. Contract Price includes Cash Allowance indicated below and is comprised of the following items:

Schedule of Cash Allowances		
<b>Materials and Installation</b>		
Emergency Generator Relocation	--	\$80,000.00
Door Hardware	--	\$50,000.00
Inspection and Testing	--	\$50,000.00
FF&E (Furniture, Fixtures & Equipment)		\$825,000.00
Signage	--	\$15,000.00
Collected amount of Cash Allowance is equal to:		<b>\$1,020,000.00</b>

### 3.4 SCHEDULING WORK COVERED BY ALLOWANCE

1. Comply with the following:
  1. Perform Work within Contract Time.
  2. Include Work in construction schedule.
  3. Consultant will supply Contractor with required documentation or information within time specified, or where such time is not specified, in sufficient time to permit construction schedule to be maintained.

### 3.5 PERFORMANCE OF WORK COVERED BY ALLOWANCES

1. Consultant will determine by whom and for what amounts Work covered by Allowances will be performed.
2. If not specified, Consultant will determine manner in which prices for Work covered by Allowances will be obtained.
3. When requested or specified, Contractor will assist the Consultant by identifying potential suppliers and Subcontractors and by obtaining prices for Work covered by Allowances.

### 3.6 CONTRACTOR'S RESPONSIBILITIES

1. Contractor's responsibilities for Work covered by Allowances shall be same as for other Work of this Contract.
2. On notification in writing of selection of supplier or Subcontractor by Consultant, Contractor will execute purchase agreement with designated supplier or enter into subcontract or amend existing subcontract with designated Subcontractor.

### 3.7 DETERMINATION OF ACTUAL COSTS

1. Actual cost of items included in an Allowance amount shall be determined by:
  1. Actual amount duly payable by Contractor to Subcontractor or suppliers, and
  2. Contractor actual cost of material and labour for Work performed by his own forces.
  3. Direct costs as specified in Supplementary Conditions and as listed above.
2. Trade discounts and refunds shall be credited to Owner.
3. Notwithstanding the foregoing, cash discounts, if any, on accounts paid by Contractor before net due. Contractor may retain date.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specified requirements allowing Contractor to propose substitutions for consideration by the Consultant that offer means or methods that differ from those indicated in the Contract Documents.
2. This Section acknowledges the Contractor's control over the work and makes provisions for proprietary or unique solutions to the Consultant's conceptual designs and requirements indicated on the Drawings and within the Specifications.

### 1.2 RELATED REQUIREMENTS

1. Division 01 – General Requirements:
  1. Section 01 61 00 – Common Product Requirements
  2. Section 01 62 00 – Product Options
  3. Section 01 81 13 – Sustainable Design Criteria

### 1.3 DEFINITIONS

1. Acceptable Products: The term Acceptable Products is used to specify products by material name, manufacturer, catalogue number, model number, or similar reference and is used and are based on the Consultant's determination that materials meet specified requirements and opinion of applicability to the project requirements.
  1. Acceptable Products listings are deemed to establish the standard of acceptance that the Consultant will consider appropriate for the Work.
  2. Any product listed in the Acceptable Products listing may be used to establish the Bid Price.
2. Base Bid: Preference will be given to Bids based on materials, assemblies or deliverables described in the Technical Specifications without adjustment for Alternate Price Bids; consideration for acceptance of pricing will not be made on alternate prices but will be based on the Base Bid price to maintain fairness for Bidders that do not have the means to provide an Alternate Price Bid.
  1. Basis-of-Design Products are used to establish Consultant's preference for a single source product listing based on performance, appearance, or configuration.
  2. Use the Basis-of-Design Product Material to establish the Bid Price unless an Addendum is issued adding additional Acceptable Products.
  3. Basis-of-Design Products designation does not limit the Contractor's ability to submit Proposed Substitutions in accordance with Substitution's requirements of this Section and specific performance requirements listed in Technical Specification Sections.
  4. The words "Basis-of-Design Materials" is also used within the technical Specifications and is synonymous with the defined meaning of "Basis-of-Design Products".
3. Substitutions: Products that in the opinion of the Contractor meets requirements of the named Acceptable Products or Basis-of-Design Products listing in the Technical Specifications of the Project Manual, and are submitted to the Consultant by Contractor Subcontractor as required by this Section for consideration for use in the Project:
  1. Unsolicited Substitutions: Substitutions presented by Contractor to Consultant, and that the Contractor has researched as meeting specified project performance requirements; Contractor will present proposed substitutions for review by Consultant.
  2. Solicited Substitutions: Consultant makes specific solicitation for substitutions that will be considered during the Bidding Period within the technical specifications:
    1. These solicitations relate to Basis-of-Design Products only unless specific indication of No Substitutions Accepted is noted within technical specifications.
    2. Consultant will notify bidders of acceptable substitutions as an additional Acceptable Product listing if found acceptable through a subsequent Addendum.

3. Solicited Substitutions will still be considered

3. Apparent Substitutions: Substitutions found in the Work that have not been formally accepted by the Consultant in accordance with the requirements of this Section; unsolicited substitutions found in the work may result in a request to remove the affected work and replaced with the specified materials or accepted with a suitable credit to the Contract where substitution is found suitable for the affected work as described later in this Section.

## 2 Products

### 2.1 SUBSTITUTIONS

1. Submit proposals for substitution as follows:

1. During Bid Period: Prepare a list of Proposed Substitutions and submit in accordance with the requirements of Division 00 – Procurement and Contracting Requirements, and as follows:
  1. Solicited Substitutions: Subcontractor is required to submit Solicited Substitutions directly to the Contractor within the time frame indicated; Contractor will provide to Consultant for review, who will issue an addendum adding substitution as an additional Acceptable Product if found acceptable through a subsequent addendum.
  2. Unsolicited Substitutions: Subcontractor is required to submit Unsolicited Substitutions directly to the Contractor; Contractor will assemble Proposed Submissions and indicate changes to Bid Price as a difference in value to the Bid Price.
2. After Award of Contract: Prepare a submission using the Consultant's standard form attached to the end of this Section; complete form in accordance with requirements of this Section and submit to the Consultant; Contractor will assemble requests for Substitutions requested by Subcontractor s and submit to the Consultant for review and as follows:
  1. Consultant will attempt to review the substitute products submittals to determine acceptability within ten (10) days after receipt of Proposed Substitutions; but this is not a guaranty for delivery where additional submittals are made or where complexity of submittal requires additional time.
3. Requests for substitutions must follow procedures indicated in this Section:
  1. Requests for substitutions that occur as a part of an RFI will not be answered and will be returned to Contractor for resubmission as a Request for Substitution.
  2. Requests for substitutions that occur as a part of a shop drawing submission will not be answered and will be returned to Contractor for resubmission as a Request for Substitution.
4. In making a Proposal for Substitution the Contractor represents:
  1. That it has personally investigated the proposal and (unless the proposal explicitly states otherwise) determined that it performs in an exactly similar way or is superior to the product or method specified.
  2. That the same guaranty will be provided as for the originally specified product or construction method, where manufacturer's warranty is a specification requirement.
  3. That aesthetic or performance requirements for the project have not been substantially altered, or that required redesign on the part of the Consultant.
  4. That it will coordinate installation of the accepted substitute into the Work, making such changes in the Work as may be required to accommodate the change.
  5. That it will bear costs and waives claims for additional compensation for costs that subsequently become apparent arising out of the substitution.
  6. That the quotation is complete and includes related costs and adjustments to adjacent construction or layouts.

### 3 Execution

#### 3.1 GROUNDS FOR ACCEPTANCE

1. No substitution will be considered until full implication of the change to Consultant's design and redesign has been fully considered, and payment for any redesign or drawing changes required by the Consultant resulting from the substitution is appropriately accounted for and paid by the appropriate parties.
2. The Consultant is not obliged to accept any Proposed Substitution; Consultant reserves the right to dismiss any item with no further explanation or accept as follows:
  1. Acceptance during Bid Period: Proposed Substitutions will be reviewed as indicated in Division 00 – Procurement and Contracting Requirements with the Contractor; acceptable substitutions will be listed in the form of an Addendum or as a Post Bid Addendum (Bid Revision).
  2. Acceptance after Award of Contract: Proposed Substitutions will be reviewed with the Contractor with respect to constructability, cost and schedule impact, and adherence to project requirements; acceptable substitutions will be administered in the form of a Change Order or Change Directive.
3. Consultant may consider acceptance of Proposed Substitutions where:
  1. Products selected by Contractor from the specified Acceptable Products or Basis-of-Design Products are not available.
  2. Delivery date of products selected from those specified would unduly delay completion of Contract.
  3. Different products or construction methods to those specified that are considered by the Contractor as performing in a manner similar to, or superior to those specified.
  4. Verification that the substitute products can be obtained, meet the performance and aesthetic standards required for the project, and meet requirements of the Building Code.
  5. Different products or construction methods that will result in credit to Contract Price and maintain the specified performance.
  6. Products or construction methods that add cost to the Contract Price may be considered where additional value or life cycle cost benefits can be demonstrated for the Owner.
  7. Products meet or exceed LEED® requirements specified in Section 01 81 13 – Sustainable Design Criteria.
4. Include with Proposed Substitutions:
  1. Complete data substantiating compliance of the proposed substitute with contract requirements including coordination and identification of modifications of adjacent construction affected by the substitution.
  2. Substitute Products: Provide the following:
    1. Product identification, including manufacturer's name and address.
    2. Manufacturer's literature, including product description, performance and test data, reference standards, and limitations.
    3. Comparison of properties to specified products.
    4. Respective costs of items originally specified and proposed substitutions indicating credit or extra to the Contract Price.
    5. Samples where appearance is relevant to consideration of Proposed Substitution.
    6. Names and addresses of similar projects where the product has been used.
    7. Listing of product criteria that proposed substitutions can contribute to project's sustainability requirements as specified in Section 01 81 13 – Sustainable Design Criteria.

3. Substitute Construction Methods: Provide the following:
  1. Detailed description of the proposed method, and drawings illustrating methods of construction.
  2. Itemized comparison of proposed substitution with product or method specified.
  3. Data relating to changes in schedule.
  4. Detailed description of modifications required by proposed substitution to adjacent materials and configurations (if any).
  5. Listing of product criteria that proposed substitutions can contribute to project's sustainability requirements as specified in Section 01 81 13 – Sustainable Design Criteria.
4. Quotation for change in contract sum, if substitution is approved, indicated as an addition or deletion from Contract Price.
5. Verification that product complies with the Building Code and Contract Documents.
5. Should Proposed Substitution be found acceptable by the Consultant, in part or in whole, the Contractor shall:
  1. Assume full responsibility and costs when substitution affects any other Work.
  2. Prepare drawings incorporating and coordinating aspects of affected Work bearing the seal and signature of an architect or engineer registered in Province of the Work.
6. Substitutions resulting from Manufacturer Acquisition or Merger: Product manufacturers merge, acquire or divest product lines through their regular business activities; these business practices do not usually alter product aesthetic, quality, properties or performance; the Consultant will consider the following when evaluating Proposed Substitutions based on changed product lines through manufacturer acquisitions and mergers:
  1. Product lines from competing companies that are subsequently merged or acquired by a single company does not convey automatic acceptance of full product range of the merged or acquired company as a substitution.
  2. Proof of performance must be submitted to the Consultant the same as with other Proposed Substitutions described in this Section to confirm similar or better performance to the Basis-of-Design or Acceptable Products listed within the technical specification sections.
  3. No request for substitution will be required where competing product lines are already listed as Acceptable Products within the technical specification sections.

### 3.2 GROUNDS FOR DENIAL

1. Unsolicited Substitutions will not be permitted and will be required to be removed and replaced with specified materials:
  1. Consultant will either select a substitute product or recommend that extraordinary delivery methods be utilized to deliver the specified product at no additional cost to the Owner in the case of the preceding.
  2. Consultant may accept credit to the value of the contract on behalf of the Owner at the Consultant's discretion where Contractor can show exceptional circumstances indicating why specified materials were not available at time of installation, and that resulted in the Unsolicited Substitution.
  3. Unsolicited Substitutions resulting from negligence in ordering specified materials in proper advance time considering place of origin of product, normal method of delivery and manufacturers ordering requirements will not be considered for credit or time adjustments.
2. Consultant reserves the right to disregard any requests for substitutions submitted that are not presented with the information required by this Section and as follows:
  1. Substitutions will not be considered that are implicit in submitted shop drawings and samples rather than formally presented proposals as described above.

2. Substitutions will not be considered that require substantial changes in the Contract Documents.

### 3.3 SUBSTITUTION REQUEST FORM

1. Use the form on the following page to request substitutions during construction period.

**REMAINDER OF PAGE LEFT INTENTIONALLY BLANK**



## SUBSTITUTION REQUEST FORM – DURING CONSTRUCTION

Project Name: \_\_\_\_\_

Project No.: \_\_\_\_\_

Date: \_\_\_\_\_

The Contractor shall coordinate all requests for Substitutions with the Consultants limitations and requirements specified in Section 01 62 00 – Product Options. The Contractor's request must be accompanied by all relevant, supporting information and documentation to allow proper review by the Consultant, Requests not containing all required information will not be considered.

Specification Section Number: \_\_\_\_\_ Specification Title: \_\_\_\_\_

- ☐ Product Data for Proposed Substitution: Provide all manufacturers literature, product information, reference standards, performance data and testing results
- ☐ Sample: where applicable substitution request must be accompanied with samples of Proposed Substitution, and where sample can assist the Consultant with reviewing, assessing, and determining suitability of the proposed substitution's physical properties.

Provide a clear, concise fully itemized comparison between Proposed Substitution and the Specified Products, append additional sheets as required where space provided is insufficient.

	Specified Products	Proposed Substitution
Product Name:	_____	_____
Product Number:	_____	_____
Manufacturer:	_____	_____
Matching Properties:	_____	_____
Property Variations:	_____	_____
Reasons for Substitution:	_____	_____
Effects on Other Parts of the Work:	_____	_____

Effect on Contract as follows:

Unit Cost Comparison:

Original Product:	\$ _____	per	_____
Substitution:	\$ _____	per	_____

Proposed Change to Contract Price

Credit to Contract: \$ \_\_\_\_\_

Additional Cost to Contract: \$ \_\_\_\_\_

Proposed Change to Contract Time

Reduce Contract Time by: \_\_\_\_\_ days

Increase Contract Time by: \_\_\_\_\_ days

*Submission of Proposed Substitution is not a direction to proceed with affected work and does not constitute a change to Contract Price or extension to Contract Time until authorized by Change Order.*

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Specification specified administrative provisions intended to facilitate responses to Requests for Information (RFI), and defines the categories of requests and methods used convey information between the parties reading the Contract Documents after execution of the Agreement and with the following limitations:
  1. This Specification section does not apply to enquiries and requests for clarification arising during the Bid Period; RFI's submitted during the Bid Period will be considered as Enquiries as defined in Division 00 – Procurement and Contracting Requirements.
  2. This Specification section does not apply to questions arising from shop drawing or sample submittals, or from questions relating to product options or substitutions.

### 1.2 RELATED REQUIREMENTS

1. Division 01 – General Requirements:
  1. Section 01 25 00 – Substitution Procedures
  2. Section 01 31 13 – Project Coordination
  3. Section 01 31 19 – Project Meetings
  4. Section 01 33 00 – Submittal Procedures
  5. Section 01 81 13 – Sustainable Design Criteria

### 1.3 DEFINITIONS

1. Request for Information (RFI): A formal process used during the construction phase of the project to facilitate communication between the Contractor, Consultant and Owner with regards to requests for additional information about the content of the Contract Documents as follows:
  1. RFI is a standard document provided by the Consultant and submitted by the Contractor requesting interpretation or clarification to the Drawings and Specifications.
  2. Consultant's response to an RFI has the same status as a Supplemental Instruction defined under the Contract.
  3. A properly prepared RFI will be considered by the Consultant as containing the following:
    1. Detailed written statements clearly stating the nature of the interpretation or clarification requested.
    2. Identify Drawings by drawing number, drawing name and location on the drawing sheet.
    3. Identify Specifications by section number, section title, and listing page and paragraph numbers.
    4. Site dimensions or conditions that are different from those indicated within Contract Documents and that affect request for interpretation or clarification.
    5. Contractor's suggested solution where request impacts construction means, methods, techniques, sequences and procedures, or as required for coordinating the various parts of the Work.
4. Contractor will identify RFI's for two specific categories of request as follows:
  1. Requests for Interpretation: Request made in accordance with contractual obligations for Consultant's third-party obligations for providing interpretations of the Contract Documents; Consultant will not provide an interpretation for questions arising from documents that are not contained in the listed Contract Documents.
  2. Requests for Clarification: Request concerning items not indicated on Drawings or contained in Specifications; requests relating to items that cannot be ascertained after Contractor has exhausted their due diligence to locate required information and, that is not apparent in the Contract Documents or subsequent to site reviews performed by the Contractor, and that is required to perform the Work.

2. Improper RFI's: An RFI that contains ambiguous language, numerous errors, or that contains incomplete information that does not identify specific components of the Drawings or Specifications, or that is sent to a party other than the Consultant.
  1. The Owner reserves the right to process Improper RFI's and invoice at standard per diem rates chargeable to the Owner by the Consultant to the Contractor.
  2. Owner will deduct these costs from Progress Payments due to the Contractor.
  3. Consultant will notify the Contractor before processing an Improper RFI.
3. Unnecessary RFI's: RFI's will not be accepted that contain requests for information that is apparent within the Contract Documents or reasonably inferable; that is apparent from site observations; or contains information that entails change of contractual responsibility; change of design; that is vague or ambiguous; or that asks for a response to shop drawings and substitutions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

1. Pre-construction Meetings: Conduct a pre-construction attended by the Contractor, the Consultant and Owner in accordance with Section 01 31 19 – Project Meetings to discuss the following:
  1. Review Consultant's RFI form and required content for timely response, limitations of content, categories of requests that will be considered as valid RFI's.
  2. Review Consultant's submission requirements, name and email address of primary contact and mode of transmission (fax, email, FTP site).
  3. Review Consultant's process for receiving, handling, and responding to RFI's including the following:
    1. In-House (Consultant's Contract Administrator) prime contact for accepting and dispersing RFI's, and out-source responsibility to Subconsultants and specialist consultants.
    2. Confirmation of reasonable response times necessary to process and complete RFI's.
    3. Electronic project management software, submission processes and record keeping requirements.
  4. Establish a baseline for reasonable quantities of RFI submissions based on project circumstances and complexities, and methods for discussing adjustments to timeframes for processing requests during peak requests.
  5. Review methods to resolve complex issues arising from RFI process; discuss methods for prioritizing critical responses and establishing mutually acceptable response times where multiple RFI's are issued.
2. Coordination: Coordinate requirements for timely response period based on number or complexity of RFI's issued during the course of the Work:
  1. Consultant will endeavor to respond within a minimum of five (5) to seven (7) Working Days or other time frame agreed upon prior to issuing any RFI's:
    1. Response times can be three (3) working days or less for individual easily resolved RFI's; complex requests may take fourteen (14) working days or longer.
    2. Consultant will request additional response time where multiple RFI's are received within a short period of time.
  2. RFI's received after 2:00 pm local time will be considered as received on the following working day.
  3. Consultant's response may include a request for additional information from the Contractor, which will result in a mutually agreed upon increase to the time required to respond to the RFI.
  4. RFI must state a date and time where need for response is different than indicated by the Consultant, or where greater urgency is required by the Contractor or Subcontractor.

5. Consultant's stated response time or other time proposed by Subcontractor or the Contractor does not represent a guaranty that RFI's will be addressed within the stated time period.
3. Record Keeping: Contractor is responsible for preparing and maintaining a log of RFI's and providing a copy to the Consultant when requested indicating any unanswered, incomplete, or outstanding RFI's:
  1. Use RFI Log during project meetings and identify an agenda point during regular site meetings to discuss status of pending and upcoming RFI's.
  2. Consultant will maintain a similar record of responses to RFI's, indicating a log of actions or reasons for non-response based on definitions contained in this Specification section.

## 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work affected by RFI's as follows:
  1. Request for Information: Submit using RFI form prepared by Consultant based on example document attached to this Specification section and as follows:
    1. Indicate correct use of Interpretation or Clarification based on definitions listed above.
    2. Complete all required entry items; handwritten entries must be fully legible after photocopying, scanning or facsimile transmission (fax).
    3. Include one topic for each RFI, submitted in chronological order with no breaks in consecutive numbering.
    4. Label each page of attachments with RFI number.
    5. Submit completed RFI using accepted mode of transmission discussed at preconstruction meeting.

## 2 Products

### 2.1 NOT USED

## 3 Execution

### 3.1 EXAMINATION

1. Validity of Request: Consultant will accept requests when one or more of the following conditions have been met by the Contractor:
  1. Pre-Submission Review: Review requests from Subcontractors, manufacturers, and suppliers before submitting any RFI to determine whether request is valid.
  2. Need for Interpretation: Subcontractor requires additional information arising from disconnects within Contract Documents, and where intent cannot be reasonably inferred from information presented in the Specifications and Drawings such as the following:
    1. Interpretation will occur when inconsistencies arise from differing information components leading to contradictions between parts of the Contract Documents.
    2. Interpretation will occur to address omissions, differences in coordination, or contradictions for placement of components indicated on Drawings and Specifications that lead to uncertainty of intent contained within the Contract Documents.
  3. Need for Clarification: Subcontractor is unable to determine material or system required for project from the Contract Documents, or where site conditions or circumstances are different from those indicated within the Contract Documents.

### 3.2 PREPARATION

1. Unanswered Bid Enquiries from Bid Period: Bid Enquiries during the bidding period are not considered RFI's and as such may not have been completely addressed through the addendum or bid revision process:
  1. Consultant informs the Subcontractor that complexity of a Bid Enquiry or timeliness of a submission may delay or cause an incomplete response requiring additional interpretation or clarification during course of the Work.
  2. It is expected that any outstanding or incomplete enquires arising from the Bid period will be submitted in the form of an RFI immediately upon award of Contract so that suitable responses can be provided by the Consultant.

### 3.3 CONTRACTOR'S RESPONSIBILITIES

1. Initiating an RFI: Contractor may, after exercising due diligence to locate required information, request clarification or interpretation of the requirements of the Contract Documents:
  1. Consultant will attempt to respond with reasonable promptness; however, if the information requested by Contractor is readily apparent from site observations, is contained in the Contract Documents or is reasonably inferable from them, the Contractor will be responsible to the Owner for reasonable costs charged by the Consultant for additional services required to provide such information.
2. Alternative to RFI's: Determine urgency of Request for Information; and wherever possible, include request for interpretation or clarification as a component of the next regularly scheduled Project Meeting:
  1. Consultant will endeavour to provide a response as a component of the meeting minutes.
  2. Consultant will accept that a special Project Meeting may be required to discuss coordination of complex or numerous RFI points within a regularly scheduled Project Meeting.
  3. Submit an RFI where item cannot be addressed during meeting, or where urgency of need or complexity of item cannot be adequately addressed during Project Meeting.
3. Completion of Standard RFI Form: Prepare Consultant's standard RFI form by completely filling in all required fields and clearly stating the nature of the request:
  1. Attach additional or covering information necessary to provide clarity to request and submitting in a timely manner, or that does not fit on the standard form provided by the Consultant.
  2. Accompany RFI's issued for coordination issues of items like pipe and duct routing, or clearances for other work shown diagrammatically requiring specific locations by including drawings or sketches drawn to scale indicating suggested solutions.
4. Acceptance of RFI's: RFI's will only be accepted from Contractor as follows:
  1. All Subcontractor RFI's must be sent to Contractor; RFI's sent directly to Consultant by Subcontractor without Contractor's prior review will not be accepted and will be returned unanswered.
  2. RFI's sent directly to Subconsultants by Subcontractors or Contractor will not be accepted and will be returned unanswered, unless agreed to before submission of RFI.
  3. Include requests from Subcontractors, manufacturers, and suppliers as a part of Contractor submission.
  4. RFI's received by Consultant that are sent directly from any Subcontractor, manufacturer and supplier; and that are not a part of the Contractor's RFI, will be returned unanswered.
5. Contract Changes Resulting from RFI Responses: Consultant will respond to properly prepared RFI's with the assumption that no change to Contract Price or Contract Time is involved with RFI's:

1. Notify Consultant immediately about any concerns arising from Consultant's response that has potential to affect Contract Price or Contract Time.
2. Do not prepare RFI's with the anticipation that responses will automatically justify increased Contract Price or extensions to Contract Time.
3. Do not proceed with any work associated with the affected RFI until a Change Order is prepared and approved, or a Change Directive is issued where urgency for continuation of the Work dictates.

#### **3.4 CONSULTANT'S RESPONSE**

1. Consultant will respond to properly prepared RFI's by one of the following methods:
  1. Directly on the submitted form or using additional attachments as appropriate to address concerns identified where no change to the Contract is anticipated.
  2. Retaining original RFI and issuing a Proposed Change Notice where Contractor indicates that a change to Contract is required.
  3. Respond by indicating that additional information or additional time is required to address the subject indicated in the RFI.
  4. Completion of response will close the RFI.
2. Consultant will identify Improper RFI's to Contractor before responding, and will attempt to respond where content does not relate to means and methods for delivery of the Work:
  1. Improper RFI's that cannot be reasonably interpreted by the Consultant will be treated the same as Unnecessary RFI's.
  2. Return of Improper RFI will close the RFI.
3. Consultant will return Unnecessary RFI's directly to Contractor unanswered with a notation Not Reviewed accompanied by wording stating specific reasons and follow-up action where required:
  1. Return of Unnecessary RFI will close the RFI.
4. Contractor or Subcontractor can disagree with Consultant's response to a properly prepared RFI, or any assessment of RFI's considered by the Consultant as Improper or Unnecessary at any time during the communication process; disagreement will result in closing the current RFI and initiation of a meeting to discuss further resolution.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  1. General project coordination procedures.
  2. Coordination of Drawings and Specifications.
  3. Administrative and supervisory personnel.
  4. Electronic project management software systems.
2. Each Subcontractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to specific Subcontractors by Contractor.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 26 10 – Requests for Information Procedures
  2. Section 01 31 19 – Project Meetings
  3. Section 01 32 00 – Schedules
  4. Section 01 33 00 – Submittal Procedures
  5. Section 01 45 00 – Quality Control
  6. Section 01 73 00 – Execution
  7. Section 01 77 00 – Closeout Procedures
  8. Section 01 81 13 – Sustainable Design Criteria
2. Division 21 – Fire Suppression
3. Division 22 – Plumbing
4. Division 23 – Heating, Ventilating, and Air Conditioning (HVAC)
5. Division 25 – Integrated Automation
6. Division 26 – Electrical
7. Division 27 – Communications
8. Division 28 – Electronic Safety and Security

### **1.3 ADMINISTRATIVE REQUIREMENTS**

1. General Coordination: Coordination that generally applies to all components of the Project Manual as follows:
  1. Review requirements for inclusion of schedule milestones to ensure timely submittal of shop drawings, product data and samples for review by Consultant, and expected time frame for review accounting for possible resubmission without delay consequences.
  2. Subcontractor shall coordinate construction activities as required with Contractor's Schedule to ensure efficient and orderly installation of each part of Work.
  3. Either before or after its own installation, notify Contractor where Subcontractor's installation of one part of Work is dependent on installation of other components.
  4. Contractor will schedule and coordinate construction activities of other Subcontractors in sequence required to obtain best results. Where availability of space is limited, Subcontractor shall coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
  5. Subcontractor shall make adequate provisions to accommodate items scheduled for later installation by other Subcontractors, under separate contract or by Contractor's own forces.

#### 1.4 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Coordination Drawings: Prepare Coordination Drawings in accordance with Mechanical and Electrical Drawings.
3. Coordination Drawings: Prepare Coordination Drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components or where coordination is required for installation of products and materials fabricated by separate entities:
  1. Indicate relationship of components shown on separate Shop Drawings.
  2. Indicate required installation sequences.
  3. Refer to Divisions 21, 22, 23 and 25 Mechanically related sections, and Division 26, 27, 28 and 29 Electrically related sections for specific coordination Drawing requirements for mechanical and electrical installations.
  4. List of required Coordination Drawings:
    1. Coordinate with Project Managers and Contract Administration for a list of coordination drawings that they think will be necessary for Project.
4. Staff Names: Within fifteen (15) working days of starting construction operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site:
  1. Identify individuals and their duties and responsibilities.
  2. List addresses and telephone numbers; including office and alternate telephone numbers.
  3. Provide names, addresses, and telephone numbers of individuals assigned as standbys in absence of individuals assigned to Project.
  4. Post copies of list in Project meeting room, in temporary site office, and by each temporary telephone.

#### 1.5 QUALITY ASSURANCE

1. Sustainability Certification Coordination: Designate an on-site party responsible for instructing workers and overseeing the environmental goals for the project in accordance with Section 01 81 13 – Sustainable Design Criteria, to manage environmental procedures and status of waste management plan and environmental protection plan at each construction meeting.

### 2 Products

#### 2.1 ELECTRONIC PROJECT MANAGEMENT SOFTWARE SYSTEMS

1. Consultant will require access and use of Contractor's project management software (i.e., Procore, Fieldwire, BIM360, etc.) to track and manage project's electronic and digital document submissions, requests for interpretation, construction communications, change directives and change orders for the project.
2. Contractor shall coordinate mutually agreeable project response timelines for requests for interpretation, shop drawing reviews and progress claims for inclusion into Consultants electronic project management software system.

#### 2.2 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. Change Orders.
  6. Other modifications to Contract.



7. Site test reports.
8. Copy of approved Work schedule.
9. Copy of LEED® reference documentation and modifications.
10. Manufacturers' installation and application instructions.
11. Labour conditions and wage schedules.
12. Applicable current editions of municipal regulations and by-laws.
13. Current building codes, complete with addenda bulletins applicable to Place of Work.

### **3 Execution**

#### **3.1 ADMINISTRATIVE PROCEDURES**

1. Subcontractor shall coordinate with Contractor scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of Work. Such administrative activities shall include, but not be limited to, the following:
  1. Preparation of schedules and coordination with Contractor's and other Subcontractor's activities.
  2. Installation and removal of temporary facilities under direction of Contractor not provided by Contractor.
  3. Delivery and processing of submittals for Contractor conveyance to Consultant and Owner.
  4. Progress meetings where required by Contractor and Owner.
  5. Contract acceptance procedures as scheduled by Contractor and as necessary to fulfill Owner's acceptance procedures.

#### **3.2 COORDINATION**

1. Contractor shall coordinate construction operations included in various Sections of Specifications to verify efficient and orderly installation of each part of Work.
2. Contractor shall coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation with Subcontractors as follows:
  1. Scheduling construction operations in sequence required to obtain best results where installation of one part of Work depends on installation of other components, before or after its own installation.
  2. Coordinating installation of different components with Subcontractors to verify maximum accessibility for required maintenance, service, and repair.
  3. Making adequate provisions to accommodate items scheduled for later installation.
3. Contractor shall prepare memoranda where necessary, for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings:
  1. Prepare similar memoranda for Owner where coordination of Owner installed Work is required.
4. Subcontractor will coordinate scheduling and timing of required administrative procedures with other construction activities, and activities of other contractors if any, to avoid conflicts and to verify orderly progress of Work. Administrative activities include, but are not limited to, the following:
  1. Preparation of Contractor's Construction Schedule.
  2. Preparation of Schedule of Values.
  3. Installation and removal of temporary facilities and controls.
  4. Delivery and processing of submittals.
  5. Progress meetings.
  6. Pre-construction conferences.
  7. Project closeout activities.

### 3.3 GENERAL INSTALLATION PROVISIONS

1. Contractor requires installer of each major component to inspect both substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
2. Contractor shall comply with manufacturer's installation instructions and recommendations, to extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents and Specifications.
3. Contractor shall inspect Materials immediately upon delivery and again prior to installation. Reject damaged and defective items and arrange for replacement.
4. Contractor shall provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.
5. Contractor will supervise Work, Subcontractor shall:
  1. Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to Contractor for final decision.
  2. Install each component during weather conditions and Project status that will ensure best possible results. Isolate each part of completed construction from incompatible material as necessary to prevent deterioration.
  3. Coordinate temporary enclosures with required inspections and tests, to minimize necessity of uncovering completed construction for that purpose.
  4. Install individual components at standard mounting heights recognized within the industry for particular applications indicated where mounting heights are not indicated. Refer questionable mounting height decisions to Contractor for final decision.
  5. Coordinate construction activities to ensure that no part of Work, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

**END OF SECTION**

## 1 General

### 1.1 PROJECT START-UP MEETING

1. Schedule a project start-up meeting within fifteen (15) working days after date of commencement of the Contract and prior to commencement of activities at the Place of the Work.
2. Purpose: to review personnel assignments, responsibilities, and administrative and procedural requirements, including site safety plans.
3. Location: Hold project start-up meeting at project's site or as otherwise indicated.
4. Minutes: Consultant will record minutes, will chair the meeting, and distribute minutes to parties of record prior to the next scheduled meeting.
5. Attendees:
  1. Contractor's Representatives: Contractor's senior management, project manager, site superintendent, representatives of major Subcontractors, and others, as necessary.
  2. Consultant's Representatives: as determined by Consultant.
  3. Owner's Representatives: as determined by Owner.
6. Agenda:
  1. Introduction of Owner's, Consultant's and Contractor's representatives.
  2. Review of significant contractual responsibilities and administrative and procedural requirements.
  3. Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
  4. Review of Owner's site safety requirements.
  5. Review of Owner's site orientation requirements.
  6. Review of Subcontractor Proposed Substitutions.
  7. Scheduling and coordination of Work, including the following:
    1. Essential services to be maintained to existing building, during renovation Work throughout stages of the Work.
    2. Safe entry and egress to be maintained.
    3. Establishing emergency procedures.
    4. Verification of closures required.
    5. Verification of requirements for fire safety and construction safety to be maintained.
    6. Noise and dust control, with regard to normal building operations.
    7. Verification of site access, storage areas and parking relative to Contractor's forces.
    8. Scheduling of critical shutdowns and changeovers
    9. Scheduling of demolition Work.
  8. Appointment of official representative of participants in Work.
  9. Progress scheduling in accordance with Section 01 32 00 – Schedules.
  10. Schedule of submission of shop drawings, samples, and colour chips in accordance with Section 01 33 00 – Submittal Procedures.
  11. Requirements for temporary facilities, site sign, offices, storage sheds, utilities, and fences in accordance with Section 01 50 00 – Temporary Facilities and Controls.
  12. Delivery schedule of specified equipment in accordance with Section 01 32 00 – Schedules.
  13. Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, and administrative requirements.
  14. Submission of Record Documents in accordance with Section 01 78 39 – Project Record Documents.
  15. Submission of maintenance material and data in accordance with Section 01 78 23 – Operation and Maintenance Data.

16. Take-over procedures, acceptance, and warranties in accordance with Section 01 77 00 – Closeout Procedures.
17. Monthly progress claims, administrative procedures, photographs, and holdbacks.
18. Appointment of inspection and testing agencies or firms in accordance with Section 01 45 00 – Quality Control.
19. Insurances and transcript of policies.
20. Other business.

## 1.2 PRE-DEMOLITION MEETINGS

1. Schedule a pre-demolition meeting prior to any activities affecting the selective demolition of building and site components. This meeting may be concurrent with pre-construction meeting.
2. Purpose: to review methods and procedures related to selective demolition, safe Work practices, and identify materials retained by Owner, if any.
3. Location: Identify Constructor's, Owner's, or Consultant's Offices, or some other location.
4. Minutes: Consultant will record minutes, will chair the meeting, and distribute minutes to parties of record prior to the next scheduled meeting.
5. Attendees:
  1. Contractor's Representatives: Contractor's project manager, site superintendent, representatives of Subcontractors affecting or affected by demolition Work, and others as necessary.
  2. Consultant's Representatives: As determined by Consultant.
  3. Owner's Representatives: as determined by Owner.
6. Agenda:
  1. Inspect and discuss condition of existing construction affected by selective demolition.
  2. Review structural load limitations of existing structure.
  3. Review demolition plan prepared by Contractor's professional engineer where applicable to demolition.
  4. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  5. Review requirements of Work performed by other trades that rely on substrates exposed by selective demolition operations.

## 1.3 PRE-CONSTRUCTION MEETINGS

1. Schedule preconstruction meetings required by technical specification sections referring to this section a minimum of one (1) week before starting affected work.
2. Purpose: to discuss coordination and installation requirements for materials and assemblies installed by different sections of the work, and to confirm rough-ins, special installation requirements, clearances, material compatibility, protection of installed materials or assemblies, and similar issues.
3. Location: Contractor's site offices.
4. Minutes: Consultant will record minutes, will chair the meeting, and distribute minutes to parties of record prior to the next scheduled meeting.
5. Attendees:
  1. Contractor's Representatives: Contractor's senior management, project manager, site superintendent, representatives of Subcontractors affecting building envelope construction, and others, as necessary.
  2. Consultant's Representatives: as determined by Consultant.
  3. Owner's Representatives: as determined by Owner.
6. Agenda:

1. Introduction of Consultants supplier's, manufacturer's, Subcontractor's or other affected individual's concerns for constructability, compatibility, or coordination.
2. Review of proposed materials and methods of construction to address stated concerns, specification and drawing requirements, and any requirements for mock-ups or sample assemblies.

#### **1.4 LEED® COORDINATION MEETINGS**

1. Schedule a series of meetings attended by Contractor, Subcontractors and suppliers at key milestones, and occurring prior to construction closeout activities; meetings can be concurrent with regular progress meetings.
2. Purpose: To review progress against LEED® submittals and onsite activities performed during work on site.
3. Location: Same location as Construction Progress Meetings listed later in this Section.
4. Attendees:
  1. Contractor's Representatives: Contractor's LEED® Champion, project manager and site superintendent, and representatives of Subcontractors affected by LEED® project requirements, and others as necessary.
  2. Consultant's Representatives: As determined by Consultant.
  3. Owner's Representatives: as determined by Owner.
5. Minutes: Contractor will chair meeting and record actionable items in minutes for LEED® Coordination Meetings.
6. Agenda:
  1. Review of LEED® Checklist requirements and submissions received to date.
  2. Review of Owner's anticipated credits based on current submissions.
  3. Other business.

#### **1.5 CONSTRUCTION PROGRESS MEETINGS**

1. Schedule regular construction progress meetings during the course of the Work.
2. Purpose: to monitor construction progress, site safety performance, and to identify problems and action required for their solution, to expedite the Work.
3. Frequency: Every two (2) weeks, or as otherwise directed by Consultant.
4. Minutes: Contractor will record minutes, will chair the meeting, and distribute minutes to parties of record prior to the next scheduled meeting.
5. Location: Contractor's site office.
6. Attendees:
  1. Contractor's Representatives: Contractor's project manager and site superintendent, and Subcontractors, suppliers and other parties involved in the Work when requested. Contractor's and Subcontractor's representatives shall be qualified and authorized to act on behalf of the party each represents.
  2. Consultant's Representatives: as determined by Consultant.
  3. Owner's Representatives: as determined by Owner.
7. Agenda:
  1. Review and approval of minutes of previous meeting.
  2. Review of items of significance that could affect progress.
  3. Review of LEED® project requirements and submittal documentation.
  4. Review of Work progress since previous meeting.
  5. Site observations, problems, conflicts.
  6. Problems which impede construction schedule.

7. Review of off-site fabrication delivery schedules.
8. Corrective measures and procedures to regain projected schedule.
9. Revision to construction schedule.
10. Progress schedule, during succeeding Work period.
11. Review submittal schedules: expedite as required.
12. Maintenance of quality standards.
13. Review proposed changes for affect on construction schedule and on completion date.
14. Review site safety and security issues.
15. Other topics for discussion as appropriate to current status of the Work.

## 1.6 COMMISSIONING MEETINGS

1. Coordinate requirements of commissioning meetings with Section 01 91 13 – General Commissioning Requirements and Section 01 81 13 – Sustainable Design Criteria.
2. Commissioning Kick-Off Meeting:
  1. Commissioning Agency (CxA) will schedule a commissioning kick-off meeting shortly after award of Contract; this meeting will be separate from the other meetings specified in this Section.
  2. Purpose: Outline the commissioning process and identify the roles and responsibilities of each team member in the commissioning process during the construction phase.
  3. Location: Determine preferred location of meeting, can be the CxA's offices or the Contractor's offices.
  4. Attendees: Contractor's representatives, affected Subcontractor's representatives, Consultant, Subconsultants, Owner and their operations and maintenance personnel.
  5. Agenda:
    1. Review specific equipment submittals for systems that will be commissioned to verify that equipment used to establish the Contract Price comply with the design intent.
    2. CxA will identify commissioning related milestones in the order they are to be completed; these commissioning milestones shall be incorporated into Contractor's Construction Schedule.
  6. Minutes: CxA will record minutes and distribute copies to attendees and other identified parties prior to the start of the first regularly schedule commissioning meeting.
3. Scheduled Commissioning Meetings:
  1. CxA will schedule regular commissioning coordination meetings throughout the construction phase, timing and duration will be determined at the first meeting.
  2. Purpose: To convey the importance of the commissioning process, to provide notice for upcoming commissioning milestones, and identify any outstanding issues or adjustments to systems or assemblies required to meet indicated performance values.
  3. Attendees: Contractor's representatives, affected Subcontractor's representatives, Consultant, Subconsultants, Owner and their operations and maintenance personnel.
  4. Agenda:
    1. Confirmation that Consultants have reviewed submittals and identify CxA's verification test procedures and system readiness checklists for the equipment that will be installed.
    2. Review the TAB reports to verify that all systems have been accurately balanced and are operating within the specified design parameters and identify any outstanding requirements or deficiencies.
  5. Minutes: CxA will record minutes and distribute copies to attendees and other identified parties prior to the start of the next regularly scheduled commissioning meeting.

## **1.7 WARRANTY MEETINGS**

1. Warranty meetings shall be held between Substantial Performance of the Work and the completion of the Warranty period.
2. Purpose: to bring to Contractor's attention Contract Deficiencies identified during warranty period, determine action required for their correction, and monitor progress of Contract Deficiency correction.
3. Frequency: called by Owner on an as-needed basis.
4. Location: as agreed to between Owner and Contractor.
5. Minutes: Contractor will record minutes, will chair the meeting, and distribute minutes to parties of record prior to the next scheduled meeting.
6. Attendees: same as construction progress meetings.
7. Agenda:
  1. Review and approval of minutes of previous meetings.
  2. Review of progress of Contract Deficiency corrections.
  3. Identification of problems impeding Contract Deficiency correction.
  4. Review of outstanding Contract Deficiencies and year-end Warranty items.
  5. Other business.

## **2 Products**

### **2.1 NOT USED**

## **3 Execution**

### **3.1 NOT USED**

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 33 00 – Submittal Procedures
  2. Section 01 61 00 – Common Product Requirements
    - 1.
  3. Section 01 78 23 – Operations and Maintenance Data
  4. Section 01 78 39 – Project Record Documents
  5. Section 01 91 13 – General Commissioning Requirements
2. Division 21 – Fire Suppression
3. Division 22 – Plumbing
4. Division 23 – Heating, Ventilating, and Air Conditioning (HVAC)
5. Division 25 – Integrated Automation
6. Division 26 – Electrical
7. Division 27 – Communications
8. Division 28 – Electronic Safety and Security

## **2 Products**

### **2.1 PROGRESS SCHEDULE**

1. Submit within one (1) week after Contract award a draft of Progress Schedule for Work to Consultant for review and comment. Consultant may request minor changes or clarifications to the draft Progress Schedule that do not affect Contractor's right to control of Work.
2. Submit within one (1) week after award of Contract, a full and completely itemized Construction Schedule clearly showing all stages and phases of the Work including:
  1. Dates for shop drawing review, up to completion of Work after draft Progress Schedule is reviewed by Consultant.
  2. Intermediate dates for completion of specific portions of Work required for the Owner's use
  3. Dates for receiving and installing any Owner purchased or supplied equipment.
3. Do not change Schedule without the Owners' and Consultant's written acceptance. If a change is necessary, submit written reasons for the change to Consultant for review and comment.
4. Indicate actual progress relative to Progress Schedule noted above as part of Progress Claim.

### **2.2 BREAKDOWN OF CONTRACT PRICE SCHEDULE**

1. Provide within one (1) week after award of contract, an itemized, clear, and concise breakdown of Total Contract Price using Masterformat™ divisions and sections organizational formatting and including the following:
  1. Separate and Itemized Prices
  2. Cash and Contingency allowances (if applicable)
  3. Goods and Service Tax (HST) payable on the total amount.

### **2.3 SUB-SCHEDULES**

1. Provide within one (1) week any and all sub-schedules defining the following portions of the Construction Progress Schedule in better detail:
  1. Door, Frame, and Hardware Installation.
  2. Mechanical.



3. Electrical.
  4. Integrated Automation.
  5. Communications.
  6. Electronic Safety and Security.
  7. Facility Start-Up.
  8. Commissioning
2. Formatting of Sub-Schedules: Provide sub-schedules in the identical format as the Construction Progress Schedule.
  3. Content of Sub-Schedules: Same as Construction Progress Schedule, with the exception that improved detail is provided.
  4. Facility Start-Up Sub-Schedules Content:
    1. List and provide a parent bar for the following:
      1. Fire suppression systems listed and identified in Division 21 – Fire Suppression.
      2. Plumbing systems listed and identified in Division 22 – Plumbing.
      3. Heating, ventilation, and air conditioning systems listed and identified in in Division 23 – Heating, Ventilating, and Air Conditioning (HVAC).
      4. Building automation systems listed and identified in in Division 25 – Integrated Automation.
      5. Electrical systems listed and identified in in Division 26 – Electrical.
      6. Communications systems listed and identified in in Division 27 – Communications.
      7. Electronic safety and security systems listed and identified in in Division 28 – Electronic Safety and Security.
    2. Include all milestone dates for the completion of Construction Progress Schedule tasks linked to the start dates for Facility Start-Up tasks.
    3. Group Facility Start-Up tasks by system and provide a separate bar for each task within each of the following activities:
      1. Pre-start tests and inspections.
      2. Start-up procedures, including manufacturer's site services where required.
      3. Testing, adjusting, and balancing.
      4. Preparation of reports.
      5. Consultant's review of systems and reports.
      6. Contract Deficiency correction.
    4. Indicate start and completion dates for each activity.
  5. Progress Revisions: Same as Construction Progress Schedule. The Contractor remains responsible and will with each update verify that all Sub-Schedules remain coordinated with Construction Progress Schedule.
  6. Submissions: Submit Sub-Schedules together with Construction Progress Schedule.

## **2.4 SUBMITTALS SCHEDULE**

1. Prepare and submit a Schedule clearly and accurately indicating required submittals specified in the technical sections of the Project Manual within four (4) weeks after Contract award, schedules will include but will not necessarily be limited to, the following:
  1. Delegated Design Submittals
    1. General Conformance.
  2. Action Submittals:
    1. Shop Drawings.
    2. Product Data.
    3. Samples.

3. Information Submittals:
  1. Qualification Statements.
  2. Personnel Certification.
  3. Design Notes.
  4. Certificates.
4. Sustainable Submittals:
  1. LEED® Submissions.
5. Project Coordination Submittals
  1. Agenda for Preconstruction Meetings.
  2. Scheduling.
6. Quality Control Submittals:
  1. Mock-Ups.
  2. Inspection and Testing.
  3. Source Quality Control Testing.
  4. Site Quality Control Testing.
7. Project Closeout Submissions:
  1. Project Record Documents.
  2. Spare Parts and Tools.
  3. Operation and Maintenance Information.
  4. Warranties and Guaranties.
2. Organize schedule by specification section, submittal type, submitting Subcontractor and expected submittal date. Provide room for additional comments as required to convey information requested.
3. Clearly and accurately indicate priority level for review in the Comments column for each item where multiple documents are submitted to Consultant for consecutive review:
  1. Provide and updated schedule on a monthly basis and submit to Consultant as a part of the Contractor Progress Claim submission.
  2. Allow appropriate time for return of submittals to ensure thorough review where multiple documents are submitted to Consultant for review.
  3. Consultant will endeavour to meet return date criteria but reserves the right to request a time extension where submitted quantities do not permit a thorough review of documents.
4. Consultant will track and log all submissions as indicated and listed in Section 01 31 13 – Project Coordination.

### 3 Execution

#### 3.1 NOT USED

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specified requirements for construction survey services required to measure and establish construction control points, stake the site, and record as constructed conditions after each major site operation.
  1. Contractor will be responsible for providing survey services required to establish and confirm layout, elevation and grade measurements for the Work required for sequential construction contract not forming a part of the Work of this Contract.
  2. Consultant will provide the Contractor with drawings indicating known site conditions, suitable for the laying out of the Work.
  3. Owner will provide the Contractor with locations of existing survey control points and property limits.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 31 13 – Project Coordination
  2. Section 01 71 23 – Site Engineering

### **1.3 ADMINISTRATIVE REQUIREMENTS**

1. Coordination of Digital Layouts: Consultant will provide digital drawing backgrounds for coordinating construction layouts, recording and identifying building layout, elevations and grade measurements, construction control points and construction progress measurements with the following limitations, and as follows:
  1. Reliance on Consultant's digital information by Contractor and Subcontractors will not denote accuracy or reliance upon Drawings as they relate to actual construction layouts.
  2. Contractor is responsible for coordinating and establishing construction layouts in accordance with Contract and indicating any variance from digital layouts to the Consultant.
  3. Contractor is responsible for coordinating with Subcontractors any differences between digital layouts provided by the Consultant and actual construction layouts as a consequence of construction measurement tolerances and modifications.
2. Coordination of Site Surveying: Contractor is responsible for coordinating work of this section and identifying detailed requirements for on-going site surveying activities associated with providing accurate records to Owner for Record Documentation.

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Requirements.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Submit qualification data for land surveyor to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
  2. Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
  3. Submit two (2) copies of certified survey signed by registered land surveyor.
  4. Submit two (2) copies of final property survey showing the Work performed and record survey data.
  5. Submit a Certificate of Compliance at completion of site grading stating the "As Constructed" grading elevations, and whether or not they differ from design grades.

## **1.5 QUALITY ASSURANCE**

1. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land surveying services of the kind indicated.

## **2 Products**

### **2.1 STOREY BOARD TAPES**

1. Pre-Manufactured Storey Board Tapes: Pre-printed horizontal and vertical storey board tapes indicating location of concealed services, locations of surface mounted components and appliances, and relationship to blocking and supports, accurately transferring Drawing layout information to site construction:
  1. Basis-of-Design Products: FRP Productivity Inc., BannerPLATE
  2. Substitutions: Similar methodologies for maintaining accurate and consistent construction layouts may be acceptable to Consultant when submitted in accordance with Section 01 25 00 – Substitution Procedures before starting construction layouts.

### **2.2 CONSTRUCTION RECORDS**

1. Record "As Constructed" information in separate site record survey books from site layout survey books.
2. Maintain "As Constructed" surveying record books on-site stored in Contractor's offices at all times; Contractor will make these books available to the Consultant for reference throughout the progress of the Work.
3. Include the following "As Constructed" information:
  1. Elevations at each station used for layout.
  2. Horizontal and vertical tie to legal control.
  3. Original ground elevation for each layout station.
  4. Elevation of ground after stripping for each layout station.
  5. Finished grade elevations for each layout station.
  6. Weekly up to date "As Constructed" information for review by Consultant and Contractor; this practice does not remove responsibility for compiling the record drawings as described below.

### **2.3 RECORD DRAWINGS**

1. Consultant will provide a clean set of drawings for the recording of "As Constructed" information.
2. Record "As Constructed" information on a daily basis and retain set on site for review by the Consultant and Contractor during the progress of the Work.
3. Consultant will provide electronic drawing files for the transfer of "As Constructed" record information; update permanent record drawings within one (1) week after completion of each major construction activity and changed site condition.

## **3 Execution**

### **3.1 SURVEY REFERENCE POINTS AND LEGAL SURVEY MARKERS**

1. Verify existing base horizontal and vertical control points designated on drawings.
2. Prepare and provide plan to Consultant showing location of all legal pins and ASCM control monuments existing in the site prior to construction.
3. Locate, confirm and protect control points and legal survey markers prior to starting site work; preserve permanent reference points during construction.
4. Make no changes or relocations without prior written notice to Consultant.

5. Report to Consultant when a reference point or legal survey marker is lost or destroyed or requires relocation because of necessary changes in grades or locations.
6. Replace control points in accordance with original survey control.
7. Replace legal survey markers lost or destroyed as a result of construction activities.

### **3.2 SURVEY LAYOUT**

1. Coordinate with Contractor for layout and protection of grade controls.
2. Establish permanent benchmark(s) as required, referred to established benchmarks by survey control points, record locations, with horizontal and vertical data.
3. Establish lines and levels, locate and layout, by instrumentation.
4. Stake for grading, cuts and fills, slopes.
5. Replace grade controls lost or destroyed as a result of construction activities.

### **3.3 CONSTRUCTION LAYOUT**

1. Verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. Notify Consultant promptly if discrepancies are discovered.
2. Engage a land surveyor to lay out the Work using accepted surveying practices:
  1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  2. Establish dimensions within tolerances indicated; do not scale Drawings to obtain required dimensions.
  3. Inform installers of lines and levels to which they must comply.
  4. Check the location, level and plumb, of every major element as the Work progresses.
  5. Notify Consultant when deviations from required lines and levels exceed allowable tolerances.
  6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
3. Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
4. Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Consultant when requested.

### **3.4 SITE ENGINEERING (SURVEYING)**

1. Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations:
  1. Do not change or relocate existing benchmarks or control points without prior written approval of Consultant.
  2. Report lost or destroyed permanent benchmarks or control points promptly.
  3. Report the need to relocate permanent benchmarks or control points to Consultant before proceeding.
  4. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
  5. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

6. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
7. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
2. Provide as-built site survey information after completion of demolition and excavation operations ready for subsequent Phase 4 – Construction Phase:
  1. Provide survey information on “AutoCAD” Data Base, as well as two sets of hardcopy white prints.
  2. Survey grade elevations shall be on a 9 m grid or as required to locate property lines and new building structural grid lines.
  3. Provide as-built survey of piling layout and pile cut-off elevations.

**END OF SECTION**

## 1 General

### 1.1 RELATED REQUIREMENTS

1. Division 01 – General Requirements:
  1. Section 01 25 00 – Substitution Procedures
  2. Section 01 26 10 – Requests for Information Procedures
  3. Section 01 31 13 – Project Coordination
  4. Section 01 32 00 – Schedules
  5. Section 01 35 73 – Delegated Design Procedures
  6. Section 01 81 13 – Sustainable Design Criteria

### 1.2 DEFINITIONS

1. Action Submittals: Submittals indicating Contractor's solutions for constructability and conformity with Consultant's design intent, and that require review and acceptance by Consultant before starting any work.
2. Informational Submittals: Submittals necessary for coordination of the Work, for delegated design not performed by the Consultant or for proof of performance, and that do not require review by the Consultant.
3. Sustainable Design Submittals: Submittals identifying product performance properties described in Specifications and that are required for LEED® recordkeeping; submitted concurrently with Action Submittals as described in Section 01 81 13 – Sustainable Design Criteria.

### 1.3 ADMINISTRATION REQUIREMENTS

1. Submittal Processing Requirements: Coordinate preparation and processing of submittals with the performance of construction all activities:
  1. Coordinate preparation of all required submittals with Contractor and deliver to the Consultant in the formats specified in this section and for products, systems or equipment as requested in the Technical Specifications Sections.
  2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and all other related activities that require successive or sequential activities to be completed:
    1. Individual submissions will not be reviewed until all related and relevant information is provided.
    2. Prepare submissions sufficiently in advance of scheduled dates for installation to facilitate and permit ample time for the Consultant's review and comment.
    3. Clearly identify which submissions have a higher priority in relation to progress of Work when multiple submissions are made.
  3. Coordinate transmittal of different types of submittals for related parts of Work so processing will not be delayed because of need to review submittals concurrently for coordination:
    1. Consultant reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
2. Submittals Schedule: Provide a task line indicating projected submission milestones based on backdating from the time they are needed to coordinate the Work in accordance with requirements in Section 01 32 00 – Schedules, clearly listing required submittals and time requirements for scheduled performance of related construction activities.
3. Submittal Processing Time: Permit enough time for submittal review, including sufficient time for re-submittals, as indicated below; Time for review will begin upon the date Consultant' received the submittal(s):

1. Consultant's stated response times listed below, or other time proposed by Contractor or Subcontractor does not represent a guaranty, warranty, or assurance that submittals will be addressed within the requested or stated time period:
  1. Consultant will endeavor to respond within time frame stated but will request additional response time where multiple submissions are received within a short period of time, or where coordination and complexity of submittals requires additional time.
  2. Consultant will advise Contractor when submittals being processed will be delayed due to coordination, quantity of submittals or complexity of review components.
  3. Contractor will discuss methods for prioritizing critical submittals and establish a mutually acceptable response time.
2. Initial Review: Allow a minimum of ten (10) working days for initial review of each submittal. Allow additional time if processing must be delayed permitting coordination with subsequent submittals.
3. Concurrent Review: When concurrent review of submittals by Consultant's Sub-consultants, Owner, or other parties is required, allow a minimum of fifteen (15) working days for initial review of each submittal. Direct transmittal to Consultant's Subconsultants will not be permitted.
4. If intermediate submittal is necessary, process it in same manner as initial submittal and allow for a minimum of five (5) additional working days for processing each re-submittal.
5. Incomplete or deficient submittals will be returned to Contractor marked Not Reviewed with a statement indicating reason for non-review.
6. No extension of Contract Time will be authorized because of failure to transmit submittals with enough advance notice to permit correct and accurate processing by the Consultant and orderly progression of the Work.
4. Submittal Transmittal Contents: Accompany submissions with transmittal letter, in duplicate, containing:
  1. Submissions from Contractor:
    1. Date and revision dates.
    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.
    6. Submittals may be rejected for not complying with these requirements.
  2. Submissions from Subcontractor:
    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 site measurements and compliance with Contract Documents.
    5. Details of appropriate portions of Work as applicable:
      1. Fabrication.
      2. Layout, showing dimensions, including identified site 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.
3. Distribution of Reviewed Submittals: Contractor shall distribute copies of final submittals to manufacturers, Subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities after Consultant's review. Show distribution on transmittal forms.
4. Use for Construction: Use only final submittals with mark indicating action taken by Consultant in connection with construction.
5. Electronic Drawing Files Available from Consultant: Electronic drawing files will be made available to Contractor by Consultant for preparation of Shop Drawings specific to this Project subject to the following conditions:
  1. The following electronic drawing files will be made available at no cost to Contractor:
    1. Site Plans, Landscape Plans, Pile or Foundation Plans, Floor Plans, Reflected Ceiling Plans, Roof Plans, and similar drawing types.
    2. Drawings indicating specific wall or floor patterns may also be included with the package where it is essential to have a pattern match in actual construction.
    3. Other drawings may be made available at the sole discretion of Consultant, provided that Contractor makes a request outlining a specific need that benefits project.
    4. Sections, details, and elevations will not be transmitted to Contractor; these documents are considered proprietary to Consultant.
  2. Electronic drawing files will be provided by e-mail, USB flash drive or via FTP Site, depending on size and quantities of requested electronic drawing files.
  3. Electronic drawing files will be provided in the file format used for production of drawings, a change to the version or format will not be undertaken by Consultant; Contractor shall be responsible to hire an outside service to change documents where formats do not meet their ability to read them.
  4. Direct requests for electronic drawing files from Subcontractor s will not be considered by Consultant.
  5. Consultant will alter electronic drawing file information not essential to Contract from materials provided to Contractor including, but not limited to, the following:
    1. Remove Title Blocks and Logos.
    2. Remove Professional Seals.
    3. Bind External Files and Blocks.
  6. Contractor shall coordinate Subcontractor requests for specific electronic drawing files; Contractor shall request specific electronic drawing files at beginning of Work:
    1. Consultant makes no warranty or guaranty that dimensions provided or established from electronic drawing files represent actual site conditions.
    2. Contractor shall remain responsible for establishing and confirming site dimensions and project conditions and providing this information to affected Subcontractors, except as limited below.
    3. In event that there is a discrepancy between electronic drawing files provided to Contractor and Bid Documents and Addenda, Bid Documents and Addenda shall govern.
    4. In the event that dimensions are not indicated, they shall not be scaled electronically from electronic drawing files. Missing dimensions shall be brought to the attention of Consultant, who will determine dimensions or direct method for determination of missing dimensions.

7. Contractor recognizes that use of electronic drawing files is at their own risk. Contractor will be required to sign an agreement accepting terms of use including, but not limited to, the following:
  1. Contractor, Subcontractor, Sub-Subcontractor, supplier, manufacturer, or other third-party agent agrees to indemnify and hold harmless Consultant from any damage, liability or costs arising from the use of electronic drawing files conveyed in file format provided.
  2. Consultant retains the copyright for electronic drawing files made available to Contractor.
  3. Use of supplied electronic drawing files for any subsequent Project is strictly forbidden without express written consent of Consultant.
  4. Consultant will not be held liable of any unauthorized use of modification of electronic drawing files provided.
  5. Consultant expressly disclaims any warranty or assurance that electronic drawing files will remain accurate beyond date that files were created.
  6. Consultant assumes no responsibility and disclaims any liability to any person or entity for any loss or damages including any special, indirect, or consequential damages caused by error or omissions in electronic drawing files and format provided, whether resulting from negligence, accident, or any other cause.
8. Consultant reserves the right to withdraw the offer for electronic drawing files where an excessive number of drawings are requested.
9. Consultant reserves the right to reject shop drawings prepared from electronic drawing files submitted to them by Contractor that have not been substantially altered from electronic drawing files provided, and as follows:
  1. Shop Drawings shall reflect constructability requirements
  2. Shop Drawings shall be detailed in accordance with requirements listed in technical specification sections

#### 1.4 SUBMITTALS

1. Electronic Submittals: Submit shop drawings, product data, design criteria, delegated design documentation, LEED® documentation, and other documents required by the specifications electronically using open-source Portable Document Format (PDF) software that is compatible with ISO 32000-1:2008 Document Management:
  1. Submission Requirements: Submit digital or digital documents and files using Contractor's project management software system as specified in Section 01 31 13 – Project Coordination.
  2. Software Writers: Any software that can save to or write a PDF including that allows for encryption and signature.
  3. Scanned Copies: Legible scanned PDF files of paper originals are acceptable; scanned submittals that are not legible will be rejected.
  4. File Size: Maximum file sizes for delivery of PDF submittals are as follows:
    1. E-Mail Delivery: Maximum 10 Megabytes (MB).
    2. FTP Site Delivery: Maximum 100 MB.
    3. Split Delivery: Break larger PDF files into small packages where necessary to meet delivery restrictions; identify split packages as "1 of 2" and "2 of 2" in the Subject Line of submission after other required information listed below.
    4. Sheet Orientation: Assemble PDF sheets in a single file; unless the resulting file is larger than 10 MB, rotated to a "Ready-to-Read" orientation with majority of text horizontal to the sheet with no additional adjustments or formatting required by the viewer.
  5. File Security: Do not set any permissions on the file; protected documents will not be accepted.

6. File Identification: File name must contain Project Number, Name of Submission, Date of Submission, Name of Fabricator/Manufacturer and Submittal Number.
7. Transmission Requirements: Send non-zipped files as an attachment to e-mail or upload to FTP site; zipped files will be rejected:
  1. E-Mail Transmission: Include same name as the attachment file name without the file type extension in the Subject Line; e-mail that does not contain appropriate subject will, as the sole discretion of the Consultant, be rejected.
  2. FTP Transmission: Notify the Consultant using e-mail that electronic format documents have been uploaded.
  3. Transmittal Layout: Include only one attachment or one topic per e-mail transmission, with the following text appearing in the body of the transmission; <> indicates text edited by sender:
    1. Attention: <Project Manager Name>.
    2. Project Number: <Insert Project Number>.
    3. Project Name: <Insert Name>.
    4. Name of Contractor: <Insert Name>.
    5. Name of Subcontractor: <Insert Name>.
    6. Name of Fabricator: <Insert Name>.
    7. Name of Product or Assembly: <Insert Name>.
    8. Submission Method: <e-mail> <FTP site>.
    9. Transmittal Body Example:

Attached is one set of <Shop Drawings> <Product Data> <Insert Name of Other Document> relating to the above-mentioned project, product, or assembly.

Attachments are for your review, comments, and acceptance prior to starting fabrication of the items listed. Please return reviewed documents to:
10. Name of Contractor: <Insert Name>.
11. Name and e-mail address of Primary Recipient: <Insert Name> and <e-mail address>.

## 2 Products

### 2.1 PURCHASE ORDERS

1. Submit electronic copies of purchase orders for time sensitive or long lead time materials; order time sensitive materials and equipment in sufficient time to allow installation within Work:
  1. Requests for substitute materials will not be considered by the Consultant where specified products, materials or items have not been ordered in sufficient advance time to facilitate, normal method of delivery, manufacturers ordering requirements, installation, and review of installation at the place of Work
  2. Contractor will make alternate arrangements including but not limited to, expedited delivery, custom fabrication, accelerating fabrication schedules, accelerated Construction and installation or use or premium time to meet project schedule where sufficient time was not allowed for delivery of materials or equipment at no additional cost or other adverse impact to the quality or cost of the Project.
2. Copy of purchase order shall clearly indicate the date of order and expected date of delivery, pricing information and any discounting structure.

### 2.2 SHOP DRAWINGS

1. Shop Drawings: Original electronic copies of drawings drawn accurately and to scale, modified standard drawings provided by manufacturers, or modified standard drawings provided by Contractor to illustrate details of portions of Work, that are specific to project requirements:

1. Do not base Shop Drawings on reproductions of Contract Documents except as allowed by use of electronic drawing files noted above.
2. Include the following information on Shop Drawings, as applicable:
  1. Information cross referenced to appropriate portions of Contract Documents
  2. Include dimensions consistent with units shown on drawings; converted values are acceptable when items or information are not produced in indicated units; conversion must be an accurate representation of converted units.
  3. Identification of products, materials, components, systems, and items
  4. Fabrication and installation drawings.
  5. Roughing-in and setting diagrams.
  6. Wiring diagrams showing site installed wiring, including power, signal, and control wiring.
  7. Shop work manufacturing instructions.
  8. Templates and patterns.
  9. Schedules.
  10. Design calculations.
  11. Compliance with specified standards.
  12. Notation of coordination requirements by specific related Subcontractors; the term "By Others" will not be acceptable.
  13. Notation of critical dimensions established by site measurement, or that have to be maintained to fit components.
2. Shop Drawing Review Stamps: Format or layout shop drawings in such a manner so that sufficient space is allocated for Contractor's and Consultant's circulation stamps, these stamps must appear on the submittal, absence of the above noted stamps will result in the submittal:
  1. Not being recognised by the Consultant or being returned to the Contractor with the comments "Not Reviewed" and "Reviewed - Revise and Resubmit"
  2. Where space for Contractor circulation and review stamps is not sufficient; Attach a separate cover sheet with a full description of shop drawing contents and affix required stamps to the cover sheet.
  3. Consultant will reject shop drawings not stamped, reviewed, and signed by Contractor.
3. Delegated Design, Design Criteria, and Notes: Submit design criteria and notes where design has been delegated to Contractor as a part of shop drawing submittals and provide information necessary to determine compliance with design intent:
  1. Submit Delegated Design shop drawings only where specified.
  2. Request advance permission from Consultant to submit shop drawings when not specified for materials, products, or systems, for Consultant's review.
  3. Delegated Design engineer must be registered in province where project is located and have expertise in area of practice reflected in shop drawings when specifications require shop drawings to bear seal of professional engineer.

## 2.3 SAMPLES

1. Submit samples for materials, assemblies, systems, equipment, or items as examples of quality, finishes or workmanship in quantities indicated and when requested by the technical specification Sections; additional samples will be considered where performance or appearance of the work is considered a critical requirement by the Contractor where samples are not specifically required.
2. Submit full range or multiple samples when variations in colour, pattern or texture is a natural occurrence of the materials being considered for use for the Work; reviewed and accepted samples will become standard of workmanship and material against which installed work will be verified.

3. Identify samples with name and number of the project, date, name of Contractor, name of Subcontractor, name of supplier/manufacture and intended use of material represented by Sample.
4. Do not proceed with fabrication or delivery of materials until Samples are reviewed; review of Samples does not imply acceptance of finished Work.
5. Work judged by Consultant as being below the standard set by sample may be rejected; in which event, Contractor will replace with acceptable Work, at no additional cost to Owner.

## **2.4 PRODUCT DATA**

1. Submit electronic copies of product data sheets, such as, manufacturers' catalogue sheets, brochures, literature, performance charts and diagrams, and similar literature used to illustrate standard manufactured products, modified as follows:
  1. Delete information not applicable to project.
  2. Supplement standard information to provide details applicable to project.
  3. Cross reference product data information to applicable portions of Contract Documents.

## **2.5 LAYING-OUT CERTIFICATE**

1. Provide laying-out certificate only where required by Authority Having Jurisdiction, and as follows:
  1. Submit Laying-Out Certificate to Consultant as soon as construction of foundations and basic ground floor levels are completed in the form of a certified survey plan from a registered Provincial Land Surveyor indicating the following:
    1. Dimensioned building plan at ground level
    2. Distance from property lines
    3. Elevation of floor used as datum
    4. Includes all buildings affected by Contract.

## **2.6 MATERIALS AND EQUIPMENT LISTS**

1. Submit a completed Materials and Equipment List of manufactured materials to Consultant within one week of Award of Contract listing manufacturers, trade names of items, and references (such as catalogue numbers).
2. Materials and Equipment List is required to enable Consultant to verify that materials meet specifications prior to preparation of Shop Drawings or installation, and to select colours and patterns.
3. Consultant will require resubmission where materials not meeting requirements are listed; do not list materials not conforming to Contract Documents; refer to Section 01 25 00 – Substitution Procedures for submission requirements substitute materials.

## **2.7 PHOTOGRAPHS – DIGITAL FORMAT**

1. Progress Photographs:
  1. Sizes: Minimum 10-megapixel image file size or 600 dpi print density.
  2. Type: Digital colour.
  3. Format: JPEG.
  4. Viewpoints: A minimum of four (4) photographs from three (3) different viewpoints will be required.
  5. Number of copies: one (1) set per month.
  6. Identification: Readable Text File (\*.rtf) referenced to photo file with name, location, purpose, and number of project and date of exposure.
  7. Viewpoints - Interior and Exterior Locations: Viewpoints determined by Consultant.
  8. Frequency: At completion of excavation, foundation, framing, and services before concealment and at completion of each discrete phase of construction.

2. Final Photographs:
  1. Sizes: Minimum 10-megapixel image size or 600 dpi print density.
  2. Type: Digital colour.
  3. Format: JPEG.
  4. Viewpoints: A minimum of three (3) photographs from five (5) different viewpoints will be required.
  5. Number of copies: Two (2) sets.
  6. Identification: Readable Text File (\*.rtf) referenced to photo file with name, location, purpose, number of the project, and date of exposure.
  7. Viewpoints: interior and exterior locations determined by Consultant.
3. Distribution of Photographs:
  1. One (1) complete set of progress and final photographs shall be submitted to Consultant.
  2. One (1) complete set of final photographs shall be submitted to Owner.
  3. Submit photographs with each Progress Claim and continuing until Substantial Performance of Work.
  4. Submit progress photographs on 89 mm diskettes, files compressed with file names referencing progress time when each photograph was prepared, (example; 2021-06-17 Foundation – Placement of Reinforcing Steel for Slab-on-Grade)
  5. Final submission shall include photographs and submitted on a Universal Serial Bus (USB), UHS-I Class 10 Memory Card with file names referencing progress time when each photograph was prepared, e.g.: 2021-06-17 Roof 10 – Placement of Window Cleaning Anchors.

## **2.8 SAFETY PROGRAM**

1. Submit proof that Contractor has developed and are involved with a viable Safety Program; Owner will use safety program as performance measurement standard for the Work; coordinate requirements and notify Owner of project safety meetings in accordance with Section 01 35 20 – Site Safety Requirements.

## **3 Execution**

### **3.1 DELEGATED DESIGN ENGINEER'S RESPONSIBILITIES**

1. Contractor's shall provide registered professional engineering services for all Sections of the Work requiring Delegated Design and Shop Drawings requiring a professional engineer's seal.
2. Registered professional engineer shall sign and seal all shop drawings and supporting documentation and stamp shop drawings with permit to practice for the Province of Ontario.
3. Registered professional engineer is responsible for review of all fabrication and installation of such components designed by them.
4. Registered professional engineer shall provide the Consultant with Letter of General Conformance confirming that work design by them is in conformance with shop drawings, code requirements and contract documents at completion of the Work.

### **3.2 CONTRACTOR'S SUBMITTAL REVIEW**

1. Review each submittal and check for compliance with Contract Documents. Note corrections and site dimensions. Mark with approval stamp before submitting to Consultant.
2. Approval Stamp: Stamp each submittal with a uniform approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and reviewed for compliance with Contract Documents.
3. Consultant will not review submittals that contain the following deficiencies or errors and will return them to the Contractor without further action:

1. Submittals that do not bare Contractor's approval stamp.
  2. Submittals that are forwarded directly from a Subcontractor or supplier.
  3. Submittals that appear not to have been initially reviewed by the Contractor.
  4. Submittals that form a part of a Request for Information, that contain obvious errors or omissions, or that contain unsolicited substitutions that have not been previously accepted by Consultant.
  5. Unsolicited submittals not identified as required by the Specifications, unless specifically identified to Consultant by Contractor as a proposed submission that aids in the sequence or constructability of the Work.
4. Contractor shall provide Consultant with written notification of deviations of any type from those indicated in the Contract Documents; Consultant will not accept any liability for deviations that are not identified by the Contractor; Contractor will remain liable for any deviations unless specifically reviewed and acknowledged in writing by the Consultant.

### 3.3 CONSULTANT'S SUBMITTAL REVIEW

1. Consultant will not review submittals concerning Contractor's implementation of means, methods, procedures, sequences or techniques, or other temporary aspects of the construction process that would normally form a part of the responsibility assigned under Contract to the Contractor.
2. Any submittals received from the Contractor that were not specifically requested in the Specifications will be immediately returned to the Contractor and stamped "Not Required for Review".
3. Consultant will review or take other appropriate action on the submittals, such as shop drawings, product data, samples, and other data, which the Contractor is required to submit, but only for the limited purpose of checking for conformance with the design concept and the information shown in the Contract Documents:
  1. This review will not include review of the accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes, construction means or methods, coordination of the work with other trades or construction safety precautions, all of which are the sole responsibility of the Contractor.
  2. Consultant's review will be conducted with reasonable promptness while allowing sufficient time in the Consultant's judgment to permit adequate review.
  3. Review of a specific item shall not indicate that the Consultant has reviewed the entire assembly of which the item is a component.
  4. Consultant will not be responsible for any deviations from the Contract Documents not brought to the attention of the Consultant in writing by the Contractor.
  5. Consultant will not be required to review partial submissions or those for which submissions of correlated items have not been received.
4. Action Submittals: Consultant will review each submittal, make marks to indicate corrections or modifications required, and return it; Consultant will stamp each submittal with a Review Stamp and will mark the stamp appropriately to indicate action taken, as follows:
  1. Reviewed – No Comment: Consultant has reviewed the submittal and included no notes, marks, or changes; work affected by submittal can proceed.
  2. Reviewed – As Noted:
    1. Consultant may include additional notes or comments that do not affect the submittal review process.
    2. Work affected by submittal can proceed without resubmission.
  3. Reviewed – Revise and Resubmit:
    1. Consultant notes that modifications to reviewed submittals are significant in nature and requests changes to submittals before starting work affected by submittals.

2. Consultant may permit proceeding with work when Contractor identifies that a significant delay in the Work will occur resulting from the resubmittal process.
3. Contractor will be required to provide assurance that modifications are made to submissions during construction, and that resubmission occurs during the course of the Work.
4. Review by Consultant not Required:
  1. Submittals do not meet the intent of the design and indicate work that is not acceptable for the Project.
  2. Submittals identified as requiring engineering design input and that have not been signed and sealed by a professional engineer responsible for the design.
  3. Submittals requiring Delegated Design and that are not accompanied by the covering letter.
  4. Submittals that have not been reviewed by the Contractor for coordination and Submittals that do not contain the Contractor's review stamp.
  5. Consultant will not permit proceeding with work affected by rejected submittals until submittals are revised and resubmitted with information pertinent to the Project.
5. Informational Submittals: Consultant will limit review of submittals to confirm coordination with design intent, and may make marks to indicate modifications required and return it; Consultant will stamp each submittal with a Review Stamp and will mark the stamp appropriately to indicate action taken as described above and as follows:
  1. Reviewed – No Comment.
  2. Reviewed – As Noted.
  3. Reviewed – Revise and Resubmit.
  4. Review by Consultant not required.
6. Sustainable Design Submittals: Sustainable Design Submittals will be reviewed following similar process as Action Submittals, with additional commentary based on environmental considerations described as a part of the items' performance requirements.
7. Concurrent Submittals: Consultant will stamp and forward submittals requiring concurrent review by their Subconsultants with a Date Stamp:
  1. Subconsultant will apply their own version of Review Stamp, having similar parameters as Consultant's action stamp and return to Consultant.
  2. Consultant will return stamped submittals to Contractor.
8. Electronically submitted documents will have an encrypted signature attached, indicating reviewer and location of PDF documents on Consultant's server.

**END OF SECTION**



## 1 General

### 1.1 RELATED REQUIREMENTS

1. Division 01 – General Requirements:
  1. Section 01 31 19 – Project Meetings
  2. Section 01 33 00 – Submittal Procedures

### 1.2 ADMINISTRATIVE REQUIREMENTS

1. Owner's Representative: Owner will provide a full list of their safety personnel to the Contractor at the Project Start-Up Meeting:
  1. The Owner may appoint additional personnel to attend safety site meetings and conduct periodic safety reviews.
2. Responsibility for Work Site Safety – This Contractor is "Prime Contractor"
  1. The Contractor for the purposes of the Occupational Health and Safety Act (Ontario), and for the duration of the Work of this Contract, the Contractor will:
    1. Be the "Prime Contractor" for the "Work Site", and
    2. Meet all requirements of the Occupational Health and Safety Act and Regulations, Workers Compensation Board legislation, the Fire Code legislation and all other applicable laws that govern workplace safety.
  2. The Contractor will direct all Subcontractors, Sub-Subcontractors, Other Contractors, employees, suppliers, workers and any other persons at the "Work Site" on safety related matters, to the extent required to fulfill its "Prime Contractor" responsibilities pursuant to the Act, regardless of:
    1. Whether or not any contractual relationship exists between the Contractor and any of these entities, and
    2. Whether or not such entities have been specifically identified in this Contract.

### 1.3 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Informational Submittals: Provide the following submittals during the course of the work:
  1. Provide Material Safety and Data Sheets (MSDS's) for all controlled products as listed in the provincial Chemical Hazards Regulation.
  2. Workers Compensation Board (Ontario) Experience Rating.
  3. Contractor's Workplace Summary and Injury Report (WSIR).
  4. Notice of Project filed with the Ontario Ministry of Labour.
  5. Registration of Constructors and Employers Engaged in Construction filed with the Ontario Ministry of Labour.
  6. Contractor's Safety Plan: Submit Contractor's Safety Plan, customized for use on this Project to incorporate the following:
    1. Permits required by the authorities having jurisdiction and Owner's standard Hot Work and Excavation Safety Permits, and Notice of Project,
    2. Emergency plans and contact name and telephone list,
    3. Copy of Contractor's liability insurance policy,
    4. Safety procedures for electrical systems, including but not limited to, de-energization and re-energization, locking out and tagging of systems, identification of energized lines, and requirements of local utilities,
    5. Safety procedures for mechanical systems, including but not limited to, isolation and depressurization of pressure systems, locking out and tagging of systems, purging of systems, and restart and refill of systems,

6. Ventilation procedures for confined spaces and MSDS work requirements,
  7. Minutes from Start-Up Meeting and Safety Meetings,
  8. List of Personal Protection Equipment (PPE) required on site,
  9. Noise control procedures,
  10. Workplace Summary and Injury Reports (WSIR) for this Project,
  11. Safety plans including procedures to meet requirements of 3.1 below,
  12. Copies of all Material Safety Data Sheets for the use of the Owner's Health Centre.
7. The Owner will review Contractor's Safety Plan and may request modifications or additions as necessary for the Work of this Contract.
  8. Contractor's Safety Plan shall be kept on site and updated after each Safety Meeting.

#### **1.4 SITE CONDITIONS**

1. Environmental Requirements: Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.

### **2 Products**

#### **2.1 NOT USED**

### **3 Execution**

#### **3.1 SAFETY REQUIREMENTS**

1. Contractor will verify that emergency procedures including appropriate First Aid facilities and First Aid personnel are in place at the Work Site.
2. Contractor will employ a full time, on-site Construction Safety Officer (CSO) who is responsible for the following:
  1. Providing new employee orientation
  2. Overseeing site activities
  3. Providing appropriate training on personal protective equipment and Workplace Hazardous Materials Information System (WHMIS)
  4. Conducting and documenting accident investigations as required
  5. Conducting daily work site inspections
  6. Conducting weekly site safety meetings, train new employees and verifying that Subcontractors, sub-subcontractors, Suppliers and others working on the site are aware of safety requirements
  7. Requirement for a full time, on-site CSO may be waived where it can be shown that the site superintendent is certified and trained to act as the Safety Officer.
3. Maintain on site sufficient quantities of PPE, including but not limited to, hard hats, safety glasses, hearing protection and other items of clothing or special equipment as necessary to verify that visitors to the site, the Consultant and the Owner's representative are adequately protected.
4. Verify that all Contractor's employees, Subcontractors, sub-subcontractors, Suppliers and others working on the site, meet clothing requirements of shirts with sleeves no shorter than midway between shoulder and elbow and full-length pants; muscle shirts or sleeveless shirts, cut-offs or shorts will not be allowed on the work site.

**END OF SECTION**

## 1 General

### 1.1 REFERENCE STANDARDS

1. Perform Work in accordance with the requirements of other sections, and with the requirements of all applicable federal, provincial and local statutes, regulations and ordinances. In case of conflict or discrepancy, the more stringent requirements shall apply.

### 1.2 DEFINITIONS

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

### 1.3 SUBMITTALS

1. Provide submittal in accordance with Section 01 33 00 – Submittals.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Prior to commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Consultant. Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.
  2. Address topics at level of detail commensurate with environmental issue and required construction tasks.
  3. Include the following as part of the environmental protection plan:
    1. Names of persons responsible for ensuring adherence to Environmental Protection Plan.
    2. Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
    3. Names and qualifications of persons responsible for training site personnel.
    4. Descriptions of environmental protection personnel training program.
    5. Erosion and sediment control plan which identifies type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures comply with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
    6. Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.
    7. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff.
    8. Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for marking limits of use areas including methods for protection of features to be preserved within authorized work areas.
    9. Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.

10. Non-Hazardous solid waste disposal plans identifying methods and locations for solid waste disposal including clearing debris.
11. Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off project site.
12. Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
13. Wastewater management plan that identifies methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.

#### **1.4 FIRES**

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

#### **1.5 WASTE DISPOSAL**

1. Do not bury rubbish and waste materials on site unless approved by Consultant.
2. Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

#### **1.6 DRAINAGE**

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

#### **1.7 SITE CLEARING AND PLANT PROTECTION (WHERE REQUIRED)**

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

#### **1.8 WORK ADJACENT TO WATERWAYS**

1. Do not operate construction equipment in waterways.

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

#### **1.9 POLLUTION CONTROL**

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

#### **1.10 NOTIFICATION**

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

### **2 Products**

#### **2.1 NOT USED**

### **3 Execution**

#### **3.1 NOT USED**

**END OF SECTION**

## **1 General**

### **1.1 SECTION INCLUDES**

1. This Section specifies requirements for delegated design submittals to account for completion of design solutions requiring engineering analysis using performance requirements and design criteria provided by the Consultant for components of the Work, and as follows:
  1. Delegated design submittals are associated with building components, elements or assemblies forming a part of the permanent Work that cannot be fully developed or detailed by the Consultant until completion of the competitive bid process.
  2. Manufacturers, fabricators, and suppliers contribute to the final development of design solutions associated with components, elements or assemblies identified by the Consultant in the Specifications.
2. Delegated design submittals include development of design solutions identified by the Consultant within the Specifications and requires completion by a supporting registered professional or certified/qualified specialist other than Consultant as follows:
  1. Delegated Design Submittals: Require submission of engineered shop drawings and documentation prepared by a supporting Professional Engineer containing seal and signature associated with fabrications, components, elements, or assemblies requiring engineering analysis of loadbearing components and connections; or mechanical or electrical engineering analysis for conformance with fire safety, life, or health safety regulations.
  2. Standard Submittals: Require submission of shop drawings and documentation prepared by a supporting registered professional or certified/qualified practitioner associated with pre-engineered or custom fabrications, components, elements, or assemblies that do not require engineering analysis as a component of the submittal in accordance with Section 01 33 00 – Submittal Procedures.
3. Delegated design submittals are only required for Work when specifically identified as 'delegated design' in the Specifications.

### **1.2 SECTION DOES NOT INCLUDE**

1. Temporary Work Performed by the Contractor: Delegated design submittals are not required for components of Work requiring engineering or development of details associated with temporary Work (for example: crane hoisting, engineered lifts, false Work, shoring, concrete formwork) that would normally form a part of the Contractor's or responsible Subcontractor's, suppliers, or manufacturer's contributions to the Work:
  1. The Consultant may request copies of details associated with temporary Work in the form of an Informational Submittal where this Work may affect permanent Work in accordance with Section 01 33 00 – Submittal Procedures.

### **1.3 RELATED REQUIREMENTS**

1. Technical Specifications Sections that make specific reference to delegated design requirements described in this Section.

### **1.4 DEFINITIONS**

1. Supporting Registered Professional or Supporting Certified/Qualified Practitioner: The registered professional (engineer, architect, or interior designer) or certified/qualified specialist contracted by the Contractor, fabricator or manufacturer to complete design of elements identified in the Specifications and Drawings, and produce delegated design submittals using performance requirements and design criteria contained within the Specifications as follows:

1. The supporting registered professional or supporting certified/qualified practitioner is not the Consultant.
  2. Supporting registered professionals must be licensed to practice in the province of the Work, have experience directly associated with the work delegated to them and are required to seal and sign submittals associated with delegated design.
  3. Supporting registered professionals and supporting certified/qualified practitioners must show proof of qualifications or certifications associated with their speciality to support design solutions required by the Specifications or when requested by Consultant.
  4. Consultant will provide additional performance requirements or design criteria when requested by the supporting registered professional or supporting certified/qualified practitioner.
2. Delegated Design Forms – Commitment to General Reviews by Architects and Engineers and Letter of General Conformance: Documents prepared by the supporting registered professional or supporting certified/qualified practitioner as recommended by PEO guidelines for providing general review of construction by the professional engineer.
  3. Engineering Judgement for Fire Rated Assembly Components: A written proposal submitted by manufacturer to the Authority Having Jurisdiction arising from a variation that modifies the manufacturer's standard listed assemblies and details to account for actual site conditions, refer to Section 07 05 53 – Fire and Smoke Assembly Identification.
  4. Shop Drawings and Other Documentation: Refer to Section 01 33 00 – Submittal Procedures, and submit information described in Specifications.

#### 1.5 REFERENCE STANDARDS

1. Ontario Association of Architects (OAA)/Professional Engineers Ontario (PEO)/Ontario Building Officials Association (OBOA):
  1. Form: Commitment to General Reviews by Architect and Engineers
2. Professional Engineers of Ontario (PEO):
  1. Practice Guidelines: Professional Engineers Providing Professional Services in Building Projects using Manufacturer Designed Systems and Components
  2. Practice Guidelines: Guideline for Professional Engineers Providing General Review of Construction

#### 1.6 ADMINISTRATIVE REQUIREMENTS

1. Coordination of Delegated Design Procedures: This Section includes suggested forms for submittal of Commitment to General Reviews by Architects and Engineers and Letter of General Conformance complying with requirements of Building Code for design solutions completed by supporting registered professionals or certified/qualified practitioners identified within technical Specifications.
2. Conformance with Professional Engineering Practice: The requirements of this Section are in general conformance with recommended Responsibilities for Engineering Services for Building Projects published by Professional Engineers of Ontario (PEO), with regards to duties of specialty professionals appointed during construction period.
3. Responsibility of Consultant: The requirements of this Section do not diminish responsibilities of Consultant's role as the Coordinating Registered Professional or their subconsultants roles as Registered Professionals of Record as follows:
  1. Contractor's and Subcontractor's supporting registered professional is responsible for completing the design solution based on performance requirements and design criteria provided by the Consultant.
  2. Consultant will review delegated design submittals as an Informational Submittal described in Section 01 33 00 – Submittal Procedures.

3. Consultant will use Informational Submittals to determine whether work is in general conformance with stated performance requirements and design criteria.
4. Responsibility of the Contractor: The requirements of this Section do not transfer overall Project liability to the supporting registered professional or supporting certified/qualified practitioner and as follows:
  1. Supporting registered professionals and supporting certified/qualified practitioners will be responsible for the documentation produced by them as described by their governing associations and referenced practice guides listed in REFERENCE STANDARDS above.
  2. Contractor will schedule ordering of Products associated with delegated design submittals and provide required documents described within this Section and Specifications to allow for review, acceptance, and coordination by the Consultant; and resubmission by supporting registered professionals before starting any work associated with this Work.
  3. Contractor is responsible for coordinating site layout and placement of Work, providing mark-ups to delegated design submittals when site measurements are different than those contained in Drawings or Specifications, or when delegated design submittals require site confirmation of dimensions.

## 1.7 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Informational Submittals: Provide the following submittals during the course of the Work when identified in the Specifications:
  1. Commitment to General Reviews by Architects and Engineers: Submit a signed and sealed Commitment to General Reviews by Architects and Engineers on company letterhead addressed to Consultant in accordance with format in Appendix A attached to the end of this Section prior to starting Work requiring design and seal of a professional engineer.
  2. Proof of Insurance Coverage: Consultant may request proof of insurance coverage from supporting registered professional or supporting certified/qualified practitioner during the course of work described in this Section.

## 1.8 PROJECT CLOSEOUT SUBMISSIONS

1. Record Documentation: Submit the following required information in accordance with Section 01 78 23 – Operation and Maintenance Data when identified in the Specifications before application for Substantial Performance of the Work:
  1. Letter of General Conformance: Submit a signed and sealed Letter of General Conformance on company letterhead addressed to Consultant in accordance with format in Appendix A attached to the end of this Section on completion of Work requiring design and seal of a professional engineer.
  2. Engineering Judgements: Submit Product literature and compliance certificates as required by Section 07 84 00 – Firestopping and include any required Engineering Judgements that became necessary to account for installation conditions that are different than tested assemblies.

## 2 Products

### 2.1 DELEGATED DESIGN SUBMITTALS

1. Performance Requirements and Design Criteria: Provide shop drawings and supporting documents for engineered Products signed and sealed by a Professional Engineer complying with performance requirements and design criteria when specifically identified in the Specifications:
  1. Requirements listed for Subcontractor apply to Contractor where delegated design requirements are required for self-performed components of the Work.



2. Delegated design submittals will be required for fabrications, components, elements, or assemblies requiring engineering analysis and final development of design solution when described in the Specifications.
  3. Submit a written request for additional information to Consultant and Contractor if performance requirements and design criteria indicated within Specifications are not sufficient for the Subcontractor's supporting registered professional to complete the design solution required for the Project.
2. Documents Signed and Sealed by Supporting Registered Professional: Consultant will implement a two-stage review process of shop drawings and supporting engineering analyses containing seal and signature of supporting registered professionals as follows:
  1. Stage-One Review: Submit documents and indication of commitment to delegated design process described above for initial review by Consultant.
  2. Consultant's Review: Consultant will review initial submission and may apply comments and coordination notes to clarify design criteria.
  3. Stage-Two Review: Submit sealed and signed documents after incorporation of Consultant's comments and coordination notes indicating that they are suitable for intended use.
3. Professional Errors and Omissions Insurance: Supporting registered professionals are required to carry insurance coverage from a recognized errors and omissions risk advisor appropriate to their discipline practice and design solution contributions to the Project:
  1. Insurance coverage applies only to the design solution prepared by the supporting registered professionals.
  2. Consultant may request proof of insurance from supporting registered professional's during the course of the Work.
4. Liability Insurance: Supporting certified/qualified practitioners are required to carry liability insurance from a recognized insurance provider appropriate to the business and design solution contributions to the Project:
  1. Insurance coverage applies only to the design solution prepared by supporting certified/qualified practitioners.
  2. Consultant may request proof of insurance from supporting certified/qualified practitioners during the course of the Work.

## **2.2 PRE-ENGINEERED AND CUSTOM COMPONENT SUBMITTALS**

1. Performance Requirements and Design Criteria: Provide shop drawings and supporting documents for pre-engineered or custom fabrications complying with performance requirements and design criteria when specifically identified in the Specifications in accordance with Section 01 33 00 – Submittal Procedures, and as follows:
  1. Requirements listed for Subcontractor apply to Contractor where pre-engineered or custom component submittals are required for self-performed components of the Work.
  2. Submit proof of speciality provided by a supporting certified/qualified practitioner or supporting registered professional when required in the Specifications.
  3. Submit a written request for additional information to Consultant and Contractor if performance requirements and design criteria indicated within Specifications are not sufficient for the Subcontractor's supporting certified/qualified practitioner or registered professional to complete the design solution required for the Project.

## **3 Execution**

### **3.1 IMPLEMENTATION**

1. Include Summary of Work described in technical Specification section as a part of the required Commitment to General Reviews by Architects and Engineers.

2. Prepare required submittals and submit to Consultant allowing time for Consultant's detailed review and acceptance before starting any Work affected by delegated design procedures.

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## APPENDIX A

### LETTER OF GENERAL CONFORMANCE – ONTARIO

<Date>

AECOM

<Consultant's Address>

<Consultant's City, Province Postal Code>

Attention: <Consultant's Registered Professional of Record>

Re: Letter of General Conformance for Delegated Design of <System of Component of Work>

<Name of Project>

<Project Number>

<City, Province>

I hereby give assurance that I have fulfilled my obligations for field review as outlined by previously submitted Engineers, Architects and Building Officials (EABO) standard form Commitment to General Review by Architects and Engineers and as required by the Ontario Building Code.

During the course of construction of this project, personnel from our firm visited the site in order to carry out general review in accordance with the performance standards of the by the Professional Engineers of Ontario (PEO) and the requirements of the Ontario Building Code. On the basis of our review, we have determined that the construction has been carried out in general conformity with the <specify description as appropriate to define area of review for delegated design undertaken> as required by the Contract Documents which formed the basis for the issuance of the building permit.

### Retained Professional Engineer

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

(Apply Seal)

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 35 73 – Delegated Design Procedures
  2. Section 01 42 19 – Reference Standards

### **1.2 DEFINITIONS**

1. Regulatory Requirements: Regulatory requirements mean laws, by-laws, ordinances, rules, regulations, codes, orders of Authority Having Jurisdiction, and other legally enforceable requirements applicable to Work and that are or become in force during performance of Work.
2. Governing Building Code: Work of this Project is based minimum requirements of the Ontario Building Code, which is considered as the Governing Building Code requirements for the Project:
  1. Specific design and performance requirements listed in the specifications or indicated on the Drawings may exceed the minimum requirements established by the referenced Building Code; these requirements will govern over the minimum requirements listed in the Building Code.

### **1.3 QUALITY ASSURANCE**

1. Regulatory Requirements: Except as otherwise specified, Contractor shall apply for, obtain, and pay all fees associated with, permits, licenses, certificates, and approvals required by regulatory requirements and Contract Documents, based on General Conditions of Contract and the following:
  1. Regulatory requirements and fees in force on date of Bid submission, and,
  2. Any change in regulatory requirements or fees scheduled to become effective after date of tender submission and of which public notice has been given before date of tender submission.

## **2 Products**

### **2.1 CONTRACT DOCUMENTS**

1. Contractor shall not be responsible for verifying that Contract Documents comply with regulatory requirements, except for where Delegated Design criteria listed in Section 01 35 73 – Delegated Design Procedures require a professional engineer to design specific elements of construction.
2. If the Contract Documents are at variance, or changes that require modification to the Contract Documents are made to regulatory requirements, by the Authority Having Jurisdiction, subsequent to date of Bid closing, the Contractor shall notify Consultant in writing, requesting direction, immediately such variance or change becomes known to them.
3. The Owner may make changes required to Contract Documents, any resulting change in Contract Price or Contract Time will be made in accordance with General Conditions of the Contract.
4. If the Contractor fails to notify the Consultant in writing and obtain the Owner's direction as required and performs Work knowing it to be contrary to regulatory requirements, the Contractor shall be responsible for and shall correct all violations thereof and shall bear all costs, expenses, and damages attributable to the Contractors or Subcontractors failure to comply with the provisions of all such regulatory requirements.

### **2.2 EASEMENTS AND NOTICES**

1. The Owner will obtain permanent easements and rights of servitude that may be required for performance of Work.

2. Contractor shall give notices required by regulatory requirements.

### **2.3 PERMITS**

1. Building Permit:
  1. The Owner will apply for, obtain, and pay for building permit.
  2. Contractor will require that specific Subcontractors obtain and pay for permits required by authorities having jurisdiction, where their Work is affected by work requiring permits.
  3. Contractor will display building permit and other permits in a conspicuous location at Place of Work.
2. Occupancy Permits:
  1. Contractor shall apply for, obtain, and pay for occupancy permits, including partial occupancy permits where required by authority having jurisdiction.
  2. Contractor will issue appropriate instructions to Contractor for correction to Work where Contract Document deficiencies are required to be corrected in order to obtain occupancy permits, including partial occupancy permits.
  3. Contractor shall correct deficiencies in accordance with Consultant's instructions. Where deficiency is not corrected, Owner reserves the right to make correction and charge Contractor for costs incurred.
  4. Contractor will turn occupancy permits over to Owner after Subcontractors have completed their portions of Work.

## **3 Execution**

### **3.1 NOT USED**

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. All references to codes, standards and standard specifications referred to in these Specifications or used on drawings shall mean and intend to be the currently adopted edition, amendment, and revision of such reference standards in effect at the time of Bid closing.
2. In the event that the most current version of a code, standard or standard specification differs from the version indicated in these Specifications:
  1. Report the discrepancy to the Consultant immediately.
  2. The most current standard will be used to establish the quality of the work or material being referenced.
3. Referenced standards and code requirements shall be considered minimum requirements only. The Specifications may indicate additional requirements in excess of those established by referenced codes and standards.
4. Applicable portions of Standards used that are not in conflict with the Contract Documents are hereby made a part of the Specifications.
5. Modifications or exceptions to Standards shall be considered as amendments, and unmodified portions shall remain in full effect.
6. In cases of discrepancies between the Specifications and Standards, the requirements of the Specification shall govern.
7. In cases of discrepancies between Codes and the Specifications, the Code requirements shall govern.
8. Where references to Codes or Standards are used in these Specifications, the Contractors must familiarize themselves with the applicable portions and shall be governed by the requirements affecting the Project.
9. The Contractor shall provide an affidavit, when requested by the Consultant, from manufacturers certifying that materials or products delivered to the project meet the requirements specified. Such certifications, however, shall not relieve the Contractor or their Subcontractors from the responsibility of complying with any added requirements specified in the Contract Documents.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 41 00 – Regulatory Requirements

### **1.3 STANDARDS ORGANIZATIONS**

1. The following list of standards organizations indicate the most common standards that may be referenced within the technical specifications:
  1. ANSI – American National Standards Institute
  2. ASTM – American Society for Testing and Materials
  3. CGA – Canadian Gas Association
  4. CGSB – Canadian General Standards Board
  5. CSA – Canadian Standards Association
  6. ULC – Underwriters Laboratories of Canada
  7. UL or ULI – Underwriters Laboratories Inc.
  8. NFPA – National Fire Protection Agency
  9. WHI – Warnock Hersey | Intertek Testing Services
2. The following limitations on marks issued by standards organizations will apply to the standards issued by the organizations listed above in this Section, and as follows:

1. Underwriters Laboratories Inc.: Only systems designated by “cUL” or “cULus” will be acceptable for use on this project. Systems indicating “UL” or “ULus” will only be considered where local authorities having jurisdiction have reviewed and accepted the systems in writing.
2. Warnock Hersey Intertek: Only materials designated by “cWHI” or “cWHIus” will be acceptable for use on this project. Materials bearing a “WH”, “WHI” or “WHIus” mark will only be considered where local authorities having jurisdiction have reviewed and accepted the materials in writing.
3. Contractor will be responsible for obtaining written acceptance of materials and submitting them to the Consultant prior to installation.

#### 1.4 ABBREVIATIONS

1. Additional Technical Societies, Associations, or Standards may be referenced in these Specifications in addition to the following abbreviations:

Name of Association	Abbreviation
Acoustical Materials Association	AMA
Air Movement & Control Association	AMCA
American Concrete Institute	ACI
American Iron & Steel Institute	AISI
American Society of Heating, Refrigerating and Airconditioning Engineers	ASHRAE
American Society of Mechanical Engineers	ASME
American Standards Association	ASA
American Wood Preservers' Association	AWPA
Architectural Woodwork Manufacturers Association of Canada	AWMAC
Canadian Institute of Steel Construction	CISC
Ceilings and Interior Systems Construction Association	CISCA
Canadian Roofing Contractors Association	CRCA
Canadian Sheet Steel Building Institute	CSSBI
Canadian Welding Bureau	CWB
Construction Specifications Canada	CSC
Factory Mutual	FM
Fenestration and Glazing Industry Alliance	FGIA
Heating, Refrigerating and Air-conditioning Institute of Canada	HRAI
Hydronics Institute	HI
Industrial Fabric Association International	IFAI
Insulated Glass Manufacturers Association of Canada	IGMAC
Master Painters Institute	MPI
National Association of Architectural Metal Manufacturers	NAAMM
National Building Code	NBC
National Lumber Grades Authority	NLGA
Ontario Building Code	OBC
Ontario Painting Contractor's Association	OPCA
Terrazzo, Tile & Marble Association of Canada	TTMAC
The Society for Protective Coatings	SSPC

## 2 Products

### 2.1 NOT USED

## 3 Execution

### 3.1 NOT USED

END OF SECTION

## **1 General**

### **1.1 SUMMARY**

1. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities.
2. Temporary utilities include, but are not limited to, the following:
  1. Water service and distribution.
  2. Sanitary facilities, including toilets, wash facilities, and drinking water facilities.
  3. Heating and cooling facilities.
  4. Ventilation.
  5. Electric power service.
  6. Lighting.
  7. Other temporary utilities required to complete work of this Section.
3. Support facilities include, but are not limited to, the following:
  1. Dewatering facilities and drains.
  2. Temporary signs.
  3. Waste disposal facilities.
  4. Site offices.
  5. Storage and fabrication sheds.
  6. Lifts and hoists.
  7. Temporary stairs.
  8. Construction aids and miscellaneous services and facilities.
  9. Other support facilities to complete work of this Section.
4. Security and protection facilities include, but are not limited to, the following:
  1. Environmental protection.
  2. Temporary enclosures.
  3. Storm water control.
  4. Tree and plant protection.
  5. Site enclosure fence.
  6. Security enclosure and lockup.
  7. Barricades, warning signs, and lights.
  8. Fire protection.
  9. Other security and protection facilities required to complete work of this Section.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 31 19 – Project Meetings
  2. Section 01 32 00 – Schedules
  3. Section 01 33 00 – Submittal Procedures
  4. Section 01 74 23 – Final Cleaning

### **1.3 REFERENCE STANDARDS**

1. Canadian Standards Association (CSA Group):
  1. CAN/CSA Z321-96 (R2006), Signs and Symbols for the Workplace
2. National Fire Protection Association (NFPA):
  1. NFPA 10-2022, Standard for Portable Fire Extinguishers
  2. NFPA 241-2022, Standard for Safeguarding Construction, Alteration, and Demolition Operations



#### 1.4 DEFINITIONS

1. Permanent Enclosure: Permanent roofing is complete, insulated, and weather tight; exterior walls are insulated and weather tight; and all openings are closed with permanent construction or substantial temporary closures.

#### 1.5 DESIGN OF TEMPORARY FACILITIES

1. Design Requirements: Contractor is responsible for design and safety of temporary facilities:
  1. Temporary facilities of such nature that engineering proficiency is required for their design to ensure safety during construction shall be designed by a professional engineer in the employ of the Contractor.
  2. Before the temporary structure is used, the engineer responsible for the design or their representative shall inspect the structure and issue a certificate stating that it has been constructed according to the engineer's design.
  3. Submit certificate to Consultant as an Informational Submittal in accordance with Section 01 33 00 – Submittal Procedures.
2. Temporary Facility Requirements: Provide hoists, cranes and moving equipment, and shoring and bracing required for hoisting, lifting, and moving equipment and materials required for the project into final position within the structure and as follows:
  1. Notify affected Subcontractor and coordinate placement of hoisting, lifting, and moving equipment, and shoring and bracings.
  2. Provide qualified personnel to operate and erect hoists, cranes and moving equipment, and shoring and bracing.
  3. Provide qualified engineer where site engineering is required to inspect and supervise erection procedures.
3. Notification Requirements: Prepare risk control plan and engineered lift study for any equipment or material movements that have the potential to overload the structure, adjacent buildings, and structures, or affect occupant safety and as follows:
  1. Notify the Consultant of engineered erection procedures for hoisting, lifting, and moving equipment, and shoring and bracings.
  2. Prepare risk control plan and engineered lift study before equipment and materials requiring detailed erection procedures sufficiently in advance of when they are scheduled to arrive on site to allow for Consultant's review.
  3. Submit risk control plan and engineered lift study to the Consultant as an Informational Submittal in accordance with Section 01 33 00 – Submittal Procedures.

#### 1.6 UTILITIES AND USAGE CHARGES

1. Cost or use charges for temporary facilities are not chargeable to Owner or Consultant and shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the following:
  1. Owner's construction forces.
  2. Project Occupants.
  3. Consultant and Subconsultants.
  4. Testing agencies.
  5. Personnel of Authorities Having Jurisdiction.
2. Water: Pay water service use charges, whether metered or otherwise, for water used for construction activities at Project site:
  1. Contractor will be responsible for all connections, disconnections, service lines, valves, and similar materials required to provide service, and pay for removal upon completion of the Work in accordance with governing regulations and ordinances.
  2. Restore permanent Work to same condition as surrounding materials after removal of temporary connections and service lines.

3. Electricity: Pay electric power service use charges, whether metered or otherwise, for electricity used for construction activities at Project site:
  1. Contractor will be responsible for all connections, disconnections, switches, service lines, and similar materials required to provide service, and pay for removal upon completion of the Work, in accordance with governing regulations and ordinances.
  2. Restore permanent Work to same condition as surrounding materials after removal of temporary connections and service lines.
  3. Contractor will arrange for 120/208-volt power, suitable for operation of tools and temporary lighting.
  4. Contractor will provide temporary lighting as required to ensure a safe worksite and provide additional site lighting for individual tasks as required by the technical sections.
4. Sanitary Facilities: Provide and maintain during the work, temporary toilets for the use of all workmen employed on the work. Toilets in the finished portion of the building shall not be used by workers. In accordance with the Provincial Board of Health Regulations under the Public Health Act. Provide separate facilities for both sexes as required:
  1. Provide separate facilities for both sexes as required and maintain in accordance with the Provincial Board of Health Regulations under the Public Health Act.
  2. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility.
  3. Maintain adequate supply. Provide covered waste containers for disposal of used material.
5. Temporary Heating in Occupied Buildings: The Owner will provide a source without charge to the Contractor, for temporary heat:
  1. Ensure the temporary heating system will maintain a minimum temperature of 16°C in the building enclosure for shell construction prior to completion of the interior work, or higher as indicated in the technical sections.
  2. Heaters and radiators specified for the project may not be used.
  3. Pay a share of costs proportional to the area assigned to the Contractor up to the date of Substantial Performance.
  4. The cost of any boilers, chimneys, pumps, piping, valves, heaters, radiators, and similar equipment necessary for a temporary hook up shall be borne by the Contractor.
  5. Any portion of the building's heating or ventilating system used by the Contractor will be restored to "new" condition, placed in permanent positions as indicated on Drawings before acceptance by the Consultant.
  6. Use of gasoline burning space heaters, open flame heaters, or salamander type heating units is prohibited.
  7. Warranty period on any new equipment used temporarily shall commence on date of Substantial Performance of the Work.

#### **1.7 SUBMITTALS**

1. Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
2. Implementation and Termination Schedule: Submit a schedule indicating implementation and termination of each temporary utility forming a part of the Construction Schedule in accordance with Section 01 32 00 – Schedules.

#### **1.8 QUALITY ASSURANCE**

1. Tests and Inspections: Contractor is required to arrange for Authorities Having Jurisdiction to test and inspect temporary utility, facility or control before use.
2. Obtain required certifications and permits.

3. Sustainable Project Facilities and Controls: Coordinate with sustainable project quality requirements for procedures associated with pollution controls, waste management and disposal, and indoor air quality during construction.

## 1.9 PROJECT CONDITIONS

1. Temporary Utilities: Contractor will at earliest feasible time, and when acceptable to Owner, change over from use of temporary service to use of permanent service:
  1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.
  2. Contractor will not allow the use of permanent system for temporary heating and ventilation purposes without written permission from the Owner.
  3. As construction progresses the Contractor will notify Subcontractors of terms and conditions for use of permanent heating system as arranged by the Owner, which may include the following:
    1. Use of permanent systems for temporary heating shall not modify terms of warranty at time of substantial performance.
    2. Operate to prevent temporary or permanent damage.
    3. Operate fans at proper resistance with filters installed.
      1. Change filters at regular intervals.
      2. Operate with proper safety devices and controls installed and fully operational.
      3. Operate systems only with treated water as specified.
    4. Contractor will make arrangements for provision of filter media on return and exhaust air outlets.
    5. Contractors will make arrangements to thoroughly clean and overhaul and have worn or damaged parts replaced before final inspection.
    6. Contractor will take measures to provide an alarm indicating system failure.
    7. Contractor will coordinate replacement of mechanical seals, regardless of condition, with new mechanical seals where pumps are used during temporary heating.
2. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
  1. Subcontractors will keep temporary services and facilities assigned to them clean and neat.
  2. Subcontractors will relocate temporary services and facilities installed by themselves as required by progress of the Work and as directed by the Contractor.

## 2 Products

### 2.1 MATERIALS

1. Provide new materials matching performance requirements of similar products contained in the Specifications for the Work; undamaged, previously used materials in serviceable condition may be used if approved by Consultant, provide materials suitable for use intended.

### 2.2 FIRE PROTECTION

1. Provide hand carried, portable, ULC rated fire extinguishers in class and extinguishing agent as indicated or a combination of extinguishers of NFPA recommended classes for exposures encountered on the work site.
2. Fire extinguishers will in accordance with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.
3. During full time of construction, while existing buildings remain occupied, maintain free unobstructed access to all sides of existing buildings for fire department vehicles. Confirm access with fire department.

### 2.3 EQUIPMENT

1. Diesel Fuelled Equipment: Equip diesel fuelled equipment with diesel oxidation catalytic converter and particulate filter; certified in accordance with US Environmental Agency (EPA) Clean Air Act and meeting ambient air quality standards established by US Occupational Health and Safety Administration (OSHA).
2. Provide equipment suitable for use intended.
3. Provide drinking water fountains, including paper cup supply.
4. Provide properly configured, NEMA polarized outlets to prevent insertion of 110 V plugs into higher voltage outlets; equipped with ground fault circuit interrupters, reset button, and pilot light.
5. Provide power distribution system circuits, and overhead and exposed for surveillance, wiring circuits, not exceeding 125 VAC, 20 A rating, and lighting circuits may be non-metallic sheathed cable in accordance with the requirements of the authorities having jurisdiction.

### 2.4 SHEDS AND STORAGE

1. There is limited space available on site for the placement of sheds and enclosed storage facilities. Contractor will schedule deliveries for immediate needs only, no storage will be allowed on site, except in the immediate area of the work.
2. Sheds and storage facilities shall provide suitable and sufficient enclosed and covered spaces, with raised flooring, to protect materials and equipment subject to damage by weather or construction, and in accordance with the following:
  1. Provide sheds only as necessary, to suitably store materials and equipment needing limited protection.
  2. Locate sheds and storage buildings so as not to interfere with construction operations.
  3. Sheds and storage buildings shall be moved or removed as required to maintain access to the work.
  4. Sheds and storage facilities shall be under lock and key and maintained in good condition until Substantial Completion.

### 2.5 SITE OFFICES

1. Provide a heated and lighted site office for use of the Contractor and job meetings.
2. Equip site office with a layout table of sufficient size for the documents for this project, and a telephone and fax machine for communications with the Owner, suppliers, and the Consultants, and be equipped with a meeting table and chairs sufficient for size of anticipated project meetings specified in Section 01 31 19 – Project Meetings.

### 2.6 SIGNS

1. Signs and notices for safety and instruction shall be in both official languages Graphic symbols shall conform to CAN/CSA Z321, Signs and Symbols for the Workplace.
2. Maintain approved signs and notices in good condition for duration of project and dispose of off site on completion of project or earlier if directed by Consultant.
3. All proposed Contractor or Subcontractor signage will be reviewed by the Consultant before erection. Any signs erected without the expressed permission of the Consultant will be permanently removed from the site by the Contractor.

### 2.7 SCAFFOLDING

1. Provide and maintain scaffolding, ramps, ladders, swing staging, and platforms required for Scope of Work requiring access.
2. Coordinate placement and notification of affected Subcontractor.

3. Install scaffolding only when backfill work has been completed and risk of damage to structure is minimized.
4. Design and engineer scaffolding in accordance with authorities having jurisdiction and provide certifications as necessary to prove compliance. Submit certificates when requested by the Consultant.

## **2.8 STAIRS**

1. Provide temporary stairs where ladders are not adequate until permanent stairs are available.

## **3 Execution**

### **3.1 INSTALLATION, GENERAL**

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

### **3.2 CONSTRUCTION LAYOUT**

1. Coordinate requirements for site engineering, construction surveying and layouts with Section 01 71 26 – Site Engineering.

### **3.3 TEMPORARY ENCLOSURE INSTALLATION**

1. Requirements specified below are additional to and are intended to supplement requirements pertaining to temporary enclosures specified elsewhere in the Contract Documents.
2. Provide temporary barriers and enclosures as required to ensure that construction work and activities continue uninterrupted and unhampered by adverse weather conditions for duration of construction period.
3. Cold Weather Conditions:
  1. In advance of expected cold weather and freezing temperatures, take necessary action to protect construction from adverse effects of weather and to maintain temperatures at specified levels.
  2. During storage, handling, and installation, maintain materials at specified temperatures. Do not allow materials to freeze or become coated with ice and snow.
  3. Provide enclosures for each phase of construction so that work may be carried out under temperature-controlled conditions.
4. As soon as construction of building envelope is sufficiently advanced, temporarily enclose and protect openings in envelope by means of temporary doors, barriers, and screens.
5. Cover unglazed window openings with heavy translucent sheeting.

### **3.4 TEMPORARY UTILITY INSTALLATION**

1. Engage appropriate local utility company to install temporary service or connect to existing service:
  1. Where utility company provides only part of the service, provide the remainder with matching, compatible materials, and equipment.
  2. In accordance with utility company recommendations.
  3. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
  4. Provide adequate capacity at each stage of construction, provide trucked in services where temporary utility is not available.

5. Obtain easements to bring temporary utilities to Project site where Owner's easements cannot be used for that purpose.

### **3.5 SUPPORT FACILITIES INSTALLATION**

1. Locate site offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
2. Maintain support facilities until near Substantial Performance:
  1. Remove before Declaration for Substantial Performance.
  2. Personnel remaining after Substantial Performance will be permitted to use permanent facilities, under conditions acceptable to Owner.

### **3.6 DEWATERING FACILITIES AND DRAINS**

1. Provide temporary drainage and dewatering facilities to maintain Project site, excavations, and construction free of water.
2. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining property, and that will endanger permanent Work or temporary facilities.
3. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.
4. Provide temporary drainage where roofing or similar waterproof deck construction is completed and where connection and operation of permanent drainage piping system has not been completed.
5. Remove snow and ice as required to minimize accumulations.

### **3.7 WASTE DISPOSAL FACILITIES**

1. Provide waste collection containers in sizes adequate to handle waste from construction operations.
2. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste.
3. Provide separate containers, clearly labelled, for each type of waste material to be deposited, if required by authorities having jurisdiction.

### **3.8 SECURITY AND PROTECTION FACILITIES INSTALLATION**

1. Secure building against illegal entry at end of each workday. Equip exterior temporary doors with hardware and locks.
2. Provide protection, operate temporary facilities, and conduct construction in ways and by methods that in accordance with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
3. Avoid using tools and equipment that produce harmful noise:
  1. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from neighbouring persons or businesses near Project site.
  2. Restrict use of noisemaking tools and equipment to in accordance with local bylaws and the authorities having jurisdiction.
4. Provide protection for trees, shrubs, and planting beds where required:
  1. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from construction damage.
  2. Protect tree root systems from damage, flooding, and erosion.
5. Install portable chain link enclosure fence with lockable entrance gates before construction operations begin:

1. Locate where indicated or enclose entire Project site or portion determined sufficient to accommodate construction operations and in accordance with requirements of authorities having jurisdiction.
2. Install in a manner that will prevent people, dogs, and other animals from easily entering site except by entrance gates.
3. Set fence posts in [compacted mixture of gravel and earth] [in concrete bases].
4. Provide gates in sizes and at locations necessary to accommodate delivery vehicles and other construction operations.
5. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
6. Provide barricades, warning signs, and lights in accordance with standards and code of authorities having jurisdiction.

### 3.9 TEMPORARY FIRE PROTECTION

1. Install and maintain temporary fire protection facilities of types needed to protect against reasonably predictable and controllable fire losses until permanent facilities are complete and operational.
  1. In accordance with requirements of authorities having jurisdiction and NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
  2. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above including, but not limited to the following:
    1. Site Offices: Class A stored pressure water type extinguishers.
    2. Other Locations: Class ABC dry chemical extinguishers or a combination of extinguishers of NFPA recommended classes for exposures.
    3. Locate fire extinguishers where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
2. Store combustible materials in containers in fire safe locations.
3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for firefighting. Prohibit smoking in hazardous fire exposure areas.
4. Supervise welding operations, combustion type temporary heating units, and similar sources of fire ignition.
5. Develop and supervise an overall fire prevention and first aid fire protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
6. Provide hoses for fire protection of sufficient length to reach construction areas. Hang hoses with a warning sign stating that hoses are for fire protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

### 3.10 OPERATION, TERMINATION, AND REMOVAL

1. Enforce strict discipline in use of temporary facilities to minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
2. Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements:
  1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
  2. Prevent water filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

3. Except for using permanent fire protection as soon as available, do not change over from using temporary security and protection facilities to permanent facilities until Declaration of Substantial Performance.

### **3.11 TERMINATION AND REMOVAL**

1. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Performance.
2. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
3. Materials and facilities that constitute temporary facilities are the property of Contractor.
4. Clean and renovate permanent facilities used during construction period in accordance with final cleaning requirements specified in Section 01 74 23 – Final Cleaning.

**END OF SECTION**



1. **GENERAL**

1.1 **Measurement and Payment**

- 1.1.1 Work outlined in this section is included in the lump sum tender price.
- 1.1.2 No extra compensation will be paid for dust control equipment and water supplied and applied on Saturdays, Sundays or holidays.

1.2 **Delivery, Storage and Handling**

- 1.2.1 Supply dust control materials and equipment in quantities and at times as required to mitigate the impacts of dust or as directed by the Engineer or City.
- 1.2.2 Store bags of dust materials and equipment in weatherproof enclosures.

2. **PRODUCTS**

2.1 **Materials**

- 2.1.1 Use of calcium chloride shall not be allowed for the control of dust. Dust shall be controlled through wetting down with water, as required, and power sweeping or by the construction of temporary access routes as required using engineered materials (i.e., Granular "A" and Granular "B").
- 2.1.2 Water: to Owner, Consultant and Engineer's approval.
- 2.1.3 Transport dusty materials in covered haulage vehicles.
- 2.1.4 Contractor shall tarp all stockpiles as required for dust control.

3. **EXECUTION**

3.1 **Application**

- 3.1.1 Apply dust control materials with equipment approved by the Owner, Consultant, and Engineer when directed by the Engineer or Owner.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies common requirements for product quality, availability, storage, handling, protection, and transportation; manufacturer's instructions; quality of the Work; and coordination and fastenings; and existing facilities.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 25 00 – Substitution Procedures
  2. Section 01 42 19 – Reference Standards
  3. Section 01 73 00 – Execution

### **1.3 REFERENCE STANDARDS**

1. Reference may be made to reference standards specific to materials required for the Project within text of each specification section; conform to these reference standards, in whole or in part as specifically requested in specifications.
2. Consultant reserves right to have such products or systems tested to prove or disprove conformance if there is question as to whether any product or system is in conformance with applicable standards.
3. Conform to latest date of issue of referenced standards in effect on date of submission of Bids except where specific date or issue is specifically noted.

### **1.4 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.

## **2 Products**

### **2.1 QUALITY OF PRODUCTS**

1. Products, materials, equipment, and articles incorporated into the Work shall be new, not damaged, or defective, and of best quality compatible with specifications for purpose intended:
  1. Furnish evidence as to type, source and quality of products provided if requested.
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:
  1. Remove and replace defective products at Contractor's own expense and be responsible for delays and expenses caused by rejection.
3. Decision rests strictly with the Consultant based upon requirements of Contract Documents where any disputes arise as to quality or fitness of products.
4. Maintain uniformity of manufacture for any particular or like item throughout the Work.
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.

### **2.2 AVAILABILITY OF PRODUCTS**

1. Review product delivery requirements and anticipate foreseeable supply delays for any items immediately upon signing Contract:

1. Notify Consultant if delays in supply of products are foreseeable in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
2. Failure to notify Consultant at commencement of Work where it subsequently appears that Work may be delayed as a result of foreseeable delays, Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.
3. Consultant reserves right to substitute more readily available Products of similar character; at no increase in Contract Price or Contract Time, where foreseeable delays cause a failure of specified Product delivery.

### **2.3 STORAGE, HANDLING AND PROTECTION OF PRODUCTS**

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 as directed by Consultant.
9. Touch-up damaged factory finished surfaces as directed by Consultant; use touch-up materials to match original; do not paint over name plates.

### **2.4 TRANSPORTATION OF PRODUCTS**

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; unload, handle and store such products.

## **3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

1. 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 reinstallation at no increase in Contract Price or Contract Time.

### **3.2 QUALITY OF WORKMANSHIP**

1. Construct Work to highest standard, executed by workers experienced and skilled in respective duties for which they are employed; immediately notify Consultant if required Work is such as to make it impractical to produce required results.
2. Do not employ anyone unskilled in their required duties; Consultant reserves right to request dismissal from site any workers deemed incompetent or careless.

3. Decisions as to standard or fitness of quality of workmanship in cases of dispute rest solely with Consultant, whose decision is final.

### **3.3 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.

### **3.4 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.

### **3.5 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.

### **3.6 FASTENINGS**

1. Coordinate types, appearance and design of fastenings and anchors with Section 01 73 00 – Execution.

### **3.7 PROTECTION OF WORK IN PROGRESS**

1. 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.

### **3.8 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, 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.

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 25 00 – Substitution Procedures

### **1.2 DEFINITIONS**

1. Acceptable Products: The term Acceptable Products is used to specify products by component material name, manufacturer, catalogue number, model number, or similar reference and is used as follows:
  1. Acceptable Products listings are based on the Consultant's determination that component materials meet specified requirements and opinion of applicability to the project requirements
  2. Acceptable Products listings are deemed to establish the standard of acceptance that the Consultant will consider appropriate for the Work.
  3. Any product listed in the Acceptable Products listing may be used to establish the Bid Price.
  4. The words 'Acceptable Materials' is also used throughout the technical Specifications and is synonymous with the defined meaning of 'Acceptable Products'.
2. Basis-of-Design Products: The term Basis-of-Design Products is used to specify a specific component material name, manufacturer, catalogue number, model number or similar reference and is used as follows:
  1. Basis-of-Design Products are used to establish Consultant's preference for a single source product listing based on performance, appearance, or configuration.
  2. Use the Basis-of-Design Products to establish the Bid Price unless an Addendum is issued adding additional Acceptable Products.
  3. Basis-of-Design Products designation does not limit the Contractor's ability to submit Proposed Substitutions in accordance with Substitution's requirements of this Section and specific performance requirements listed in Technical Specification Sections.
  4. The words 'Basis-of-Design Materials' is also used throughout the technical Specifications and is synonymous with the defined meaning of 'Basis-of-Design Products'.

### **1.3 PRODUCT OPTIONS**

1. Performance or Prescriptive Standards: Select any product, assembly or component material that meets or exceeds the specified standards for products specified only by referenced standards and performance criteria.
2. Acceptable Products: Select any named product, assembly or component material contained in the listing of Acceptable Products.
3. Basis-of-Design Products: Use the named product contained in the Basis-of-Design Products listing unless an addendum is issued indicating acceptance of additional Acceptable Products.
4. Incorporation of Specified Options: Contractor agrees to coordinate the installation of the selected option into the Work:
  1. Make any changes in the Work as may be required to accommodate the selected option
  2. Notify Consultant where the selected option is inconsistent with the layouts and configurations indicated on Drawings and Schedules
  3. Bear costs and waive claims for additional compensation for costs that are implicit in the use of listed options including costs of re-design, and preparation of drawings and details required by the Consultant.

#### 1.4 SUBSTITUTIONS

1. Contractor may submit request for acceptance of additional Acceptable Products meeting specified requirements contained in Technical Specifications can be shown to meet Project requirements; make submissions in accordance with Section 01 25 00 – Substitution Procedures.
2. Substitutions will be considered where the Technical Specification provides for selection of an option that is not consistent with the Drawings and Schedules; as in the case of a piece of equipment that differs from the equipment detailed in dimensions, service requirements, loads imposed on structures, or similar parameters.
3. Substitutions will be considered where Contractor is of the opinion that a product, assembly, or installation meets or exceeds the requirements of the named Acceptable Products or Basis-of-Design Products listings in accordance with Section 01 25 00 – Substitution Procedures.

#### 2 Products

##### 2.1 NOT USED

#### 3 Execution

##### 3.1 NOT USED

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:

1. Section 01 32 00 – Schedules

### **1.2 ADMINITRATIVE REQUIREMENTS**

1. Coordination:

1. Contractor will coordinate Owner supplied products with the Construction Schedule for delivery dates.
  2. Contractor will coordinate with the Owner for installation of Owner installed items, blocking and servicing requirements and confirm dimensional requirements for items being built-in or attached to Contractor's work.
  3. Contractor will coordinate Owner supplied products, installed by the Contractor for installation requirements, blocking and servicing requirements and confirm dimensional requirements for items being built-in or attached to Contractor's work.

## **2 Products**

### **2.1 NOT USED**

## **3 Execution**

### **3.1 PREPARATION**

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

5. Handle products at site including un-crating and storage.
6. Protect products from damage, and from exposure to elements.
7. Assemble, install, connect, adjust, and finish products.
8. Provide installation inspections required by public authorities.
9. Repair or replace items damaged by Contractor or Subcontractor on site (under their control).

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. Provide survey services to measure and establish construction control points, stake the site, and record as constructed conditions after each major site operation.
  1. Provide survey services required to establish and confirm layout, elevation and grade measurements for the Work.
  2. Consultant will provide the Contractor with drawings indicating known site conditions, suitable for the laying out of the Work.
  3. Owner will provide the Contractor with locations of existing survey control points and property limits.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 31 13 – Project Coordination
  2. Section 01 50 00 – Temporary Facilities and Controls
  3. Section 01 91 13 – General Commissioning Requirements

### **1.3 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate work of this Section and identify detailed requirements for on-going site surveying requirements and Owner's verification requirements for surveyed pile locations and extents of excavation.

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures and Section 01 78 39 – Project Record Documents.
2. Action Submittals: Provide the following submittals at completion of the work of this Section:
  1. As Constructed Drawings: Submit two (2) copies of the following documents signed by a registered land surveyor:
    1. Certified Survey: Showing setbacks, appurtenances, property lines, encroachments, rights-of-way and other permanent major site features.
    2. Final Grading Survey: Showing at completion of site grading stating the "As Constructed" grading elevations and indicating differences from design grades as + or – dimensions from observed conditions.
    3. Final Property Survey: Showing the Work performed and record survey data.
3. Informational Submittals: Provide the following submittals during the course of the work:
  1. Qualification Data: Submit qualification data for land surveyor demonstrating their capabilities and experience; include lists of completed projects with project names and addresses, names and addresses of consultants and owners.
  2. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with dimensions shown on drawings and meet requirements of the municipal Authority Having Jurisdiction.

### **1.5 QUALITY ASSURANCE**

1. Qualifications: Use a professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land surveying services of specified in this Section, and as follows:
  1. Surveyor shall be an independent professional land surveyor, licensed to practice in the province of Ontario for the duration of the Work, to certify the accuracy of the survey work.

2. Perform surveying required by the Work using, or under the direct supervision of, a professional land surveyor.
3. Independent as used above means a person not in the regular employment of the Contractor or having any vested interest in the Contractor's business.

## **2 Products**

### **2.1 PERFORMANCE REQUIREMENTS**

1. Surveying Requirements: Perform all surveys for layout and performance of the Work, reduce field notes, and make calculations and drawings necessary to carry out such work including, but not limited to, the following:
  1. Check relative positions of monuments and benchmarks being used.
  2. Immediately report any damaged or out-of-position monuments to the Consultant, and actions taken to correct survey marks.
  3. Check relative positions each time the monument or benchmark are used during the progress of the Work.
2. Datum: Correctly locate all lines and grades required for performing measurements necessary for construction and completion of the Work from established reference points and information is shown on the Drawings.
3. Equipment and Personnel: Use only instruments and other survey equipment that are accurate, suitable for surveys required in accordance with recognized professional standards, and in proper condition and adjustment at all times.

### **2.2 LAYOUT DRAWINGS**

1. Consultant will provide electronic drawing backgrounds for recording and identifying building layout, elevations and grade measurements, construction control points and construction progress measurements.

### **2.3 STOREY BOARD TAPES**

1. Pre-Manufactured Storey Board Tapes: Pre-printed horizontal and vertical storey board tapes indicating location of concealed services, locations of surface mounted components and appliances, and relationship to blocking and supports, accurately transferring Drawing layout information to site construction:
  1. Basis-of-Design Products: FRP Productivity Inc., BannerPLATE
  2. Substitutions: Similar methodologies for maintaining accurate and consistent construction layouts may be acceptable to Consultant when submitted in accordance with Section 01 25 00 – Substitution Procedures before starting construction layouts.

### **2.4 CONSTRUCTION RECORDS**

1. Record "As Constructed" information in separate field books from layout field books.
2. Maintain "As Constructed" field books on-site stored in Contractor's offices at all times; Contractor will make these books available to the Consultant for reference throughout the progress of the Work.
3. Include the following "As Constructed" information:
  1. Elevations at each station used for layout
  2. Horizontal and vertical tie to legal control
  3. Original ground elevation for each layout station
  4. Elevation of ground after stripping for each layout station
  5. Finished grade elevations for each layout station
  6. Installed piling layout and pile cut-off elevations indicating deviations as a + or – value from Drawings

7. Weekly up to date "As Constructed" information for review by Consultant and Contractor; this practice does not remove responsibility for compiling the record drawings as described below.

## **2.5 RECORD DRAWINGS**

1. Consultant will provide a clean set of drawings for the recording of "As Constructed" information.
2. Record "As Constructed" information on a daily basis and retain set on site for review by the Consultant and Contractor during the progress of the Work.
3. Consultant will provide electronic drawing files for the transfer of "As Constructed" record information; update permanent record drawings within one (1) week after completion of each major construction activity and changed site condition.

## **3 Execution**

### **3.1 SURVEY REFERENCE POINTS AND LEGAL SURVEY MARKERS**

1. Verify existing base horizontal and vertical control points designated on drawings.
2. Prepare and provide plan to Consultant showing location of all legal pins and control monuments existing in the onsite prior to construction.
3. Locate, confirm and protect control points and legal survey markers prior to starting site work; preserve permanent reference points during construction.
4. Make no changes or relocations without prior written notice to Consultant.
5. Report to Consultant when a reference point or legal survey marker is lost or destroyed or requires relocation because of necessary changes in grades or locations.
6. Replace control points in accordance with original survey control.
7. Replace legal survey markers lost or destroyed as a result of construction activities.

### **3.2 SURVEY LAYOUT**

1. Coordinate with Contractor for layout and protection of grade controls.
2. Establish permanent benchmark(s) as required, referred to established benchmarks by survey control points, record locations, with horizontal and vertical data.
3. Establish lines and levels, locate and layout, by instrumentation.
4. Stake for grading, cuts and fills, slopes.
5. Replace grade controls lost or destroyed as a result of construction activities.

### **3.3 CONSTRUCTION LAYOUT**

1. Verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. Notify Consultant promptly if discrepancies are discovered.
2. Engage a land surveyor to lay out the Work using accepted surveying practices:
  1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  2. Establish dimensions within tolerances indicated; do not scale Drawings to obtain required dimensions.
  3. Inform installers of lines and levels to which they must comply.
  4. Check the location, level and plumb, of every major element as the Work progresses.
  5. Notify Consultant when deviations from required lines and levels exceed allowable tolerances.
  6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

3. Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
4. Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Consultant when requested.

### 3.4 STOREY BOARD LAYOUT

1. Storey Boards: Measure offsets from batter boards, chalk and string lines, tracing tapes and storey boards to establish accurate layout and coordination between building components transferred between Drawings and that are required for require horizontal and vertical alignment between various components of the Work including the following items:
  1. Storey Layouts: Confirm and coordinate placement of building services, penetrations and other items concealed within floor storeys and roof construction.
  2. Partition Layouts: Confirm and coordinate locations of partitions, services and penetrations through partitions, including placement of blocking required for support of components mounted to partitions.
  3. Permanent Markers: Permanent markers will not be permitted where surfaces being marked are required to form final finish surfaces such as, exposed concrete floors, ceilings and partitions, or exposed structural steel receiving site applied architectural coatings.

### 3.5 SITE ENGINEERING

1. Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations:
  1. Do not change or relocate existing benchmarks or control points without prior written approval of Consultant.
  2. Report lost or destroyed permanent benchmarks or control points promptly.
  3. Report the need to relocate permanent benchmarks or control points to Consultant before proceeding.
  4. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
  5. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  6. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  7. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
2. Provide as-constructed site survey information after completion of demolition and excavation operations ready for subsequent Construction Package:
  1. Provide survey information on CAD Data Base compatible with Consultant's software, as well as two sets of hardcopy white prints.
  2. Survey grade elevations shall be on a 9 m grid or as required to locate property lines and new building structural grid lines.
3. Structural Elements:
  1. Stake locations of piling layout and pile cut-off elevations.
  2. Stake centreline of structural bearing points, footings, anchor bolts, and other features.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies general procedural requirements governing execution of the Work including, but not necessarily limited to, the following:
  1. Construction layout.
  2. Site engineering and surveying.
  3. General installation of products.
  4. Progress cleaning.
  5. Starting and adjusting.
  6. Protection of installed construction.
  7. Correction of the Work.
2. This Section specifies general items that apply to the entire project and are addressed to the Contractor unless indicated otherwise.
3. It remains the responsibility of the Contractor to ensure compliance by the various Subcontractors with all applicable general requirements of the Specifications Sections contained in the Project Manual.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 31 13 – Project Coordination
  2. Section 01 31 19 – Project Meetings
  3. Section 01 33 00 – Submittal Procedures
  4. Section 01 71 23 – Site Engineering
  5. Section 01 73 29 – Cutting and Patching
  6. Section 01 74 23 – Final Cleaning
  7. Section 01 77 00 – Closeout Procedures
  8. Section 01 78 39 – Project Record Documents
2. Division 21 – Fire Suppression

### **1.3 REFERENCE STANDARDS**

1. National Fire Protection Association (NFPA):
  1. NFPA 241-2022, Standard for Safeguarding Construction, Alteration, and Demolition Operations

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination of Hours of Work: Confine hours of Work on site from 07:00 to 18:00 hours, local time, Monday through Friday, and as follows:
  1. Review hours of work with Owner
  2. Conduct work undertaken during normal operating hours in a manner that does disrupt Owner's operations
  3. Arrangements for extended hours to those stated above or for any Work required on Saturdays, Sundays or statutory holidays must be pre-arranged in writing with the Owner's representative through the Consultant.
2. Coordination of Site Security: Full protection of the Work from damage is the Contractor's responsibility; provide a watchman if necessary to prevent damage when the site is unoccupied.
3. Coordination of Owner's Occupancy: Owner reserves the right to occupy the building and site for installation of equipment and storage of supplies at any time prior to date of Substantial Performance:

1. Such possession or use shall not be construed as final acceptance of the project or any portion thereof.
2. Contractor will provide and maintain full services (heat, light, water, etc.) between time of occupancy by Owner, to date of Substantial Performance, at no cost to Owner.

#### 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Informational Submittals: Provide the following submittals during the course of the work:
  1. Surveyor Qualifications: Submit qualification data for land surveyor to demonstrate their capabilities and experience:
    1. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
  2. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements as follows:
    1. Submit two (2) copies of certified survey signed by registered land surveyor.
    2. Submit two (2) copies of final property survey showing the Work performed and record survey data.

#### 1.6 DELIVERY, STORAGE AND HANDLING

1. Deliver materials in original wrapping or containers, with manufacturer's labels and seals intact; comply with requirements of Workplace Hazardous Materials Information System (WHMIS) as required by local Authority Having Jurisdiction, and as follows:
  1. Time deliveries and unloading to prevent traffic congestion; do not obstruct the use of adjacent buildings.
  2. Be advised that this is a functioning facility and deliveries to the site must be properly coordinated.
  3. Time deliveries to avoid interference and delays to the Construction Schedule; order material to ensure delivery when required for use:
    1. Provide for continuity of supply to avoid change of supplier or materials during any phase of the Work.
    2. Obtain an acceptable substitute at no extra cost to the Owner or obtain the specified material and accept full liability for any delay in completion as directed by the Consultant where Consultant determines that delay could have been avoided by prudent scheduling and order placement.
2. Storage and Handling Requirements: Handle and store materials in accordance with manufacturer's recommendations and prevent damage, inclusion of foreign matter, rusting, staining and defects which will affect performance and appearance, and as follows:
  1. Items having high performance factory finishes such as baked enamel, porcelain enamel or polished metal shall be adequately and continuously protected from scratches or other damage while in transit, during installation, and until Substantial Performance for the project.

#### 1.7 SITE CONDITIONS

1. Smoking Policy: Facility is a smoke free environment; Subcontractors' forces will not be allowed to smoke anywhere on site, both inside and outside of buildings except in area as directed by the Contractor; keep designated smoking areas clean and sanitary, do not permit butts to accumulate or enter the watershed.
2. Consumables Policy: Food or drink consumption by Subcontractors' forces will only be permitted within areas designated by Contractor; keep designate eating areas clean and sanitary; use closed waste receptacles and remove trash on a daily basis.

3. Overloading of Structures: Take precautions to prevent any part the structure from being loaded with a load greater than its calculated bearing capacity until completion of construction:
  1. Make every temporary support as strong as permanent support.
  2. Do not place load on concrete floors until they have obtained their permanent set and Consultant's authorization has been received.

## 2 Products

### 2.1 MANUFACTURERS

1. Manufacturer's Directions: Comply with manufacturer's printed directions where a proprietary product is used:
  1. Obtain written or printed directions or instructions from manufacturer.
  2. Do not rely on labels or directions enclosed with product.
  3. Interpret recommended practices as directives.
  4. Failure to comply with these requirements, or those relating to initial supervision by the manufacturer's representative, shall authorize the Consultant to require any opening up, removal and re-installation, or testing, that are considered necessary, at Contractor's expense.

### 2.2 MATERIALS

1. Relics and Antiquities: Protect relics and antiquities and items of historical or scientific interest such as cornerstones and contents, commemorative plaques, inscribed tablets, and similar objects found on site or in buildings being demolished:
  1. Items will remain the property of the Owner.
  2. Give immediate notice to Consultant if evidence of archaeological finds are encountered during construction and await written instructions before proceeding with Work in this area.
2. Publicity: All publicity relating to this project is subject to the approval of the Owner:
  1. No mention of the Project in advertising or articles in any publication will be permitted unless approved by the Owner.
  2. Publicity or advertising implying endorsement of a product by the Owner will not be permitted.

## 3 Execution

### 3.1 EXAMINATION

1. Construction Layout: Verify layout information shown on Drawings, in relation to the property survey and existing benchmarks; notify Consultant promptly where discrepancies are discovered and as follows:
  1. Lay out the work accurately
  2. Provide sufficient batter boards or monuments to preserve the main lines and levels.
  3. Take measurements from survey pins and established benchmarks.
  4. Verify all grades, lines, levels, and site dimensions, and report any errors or inconsistencies to the Consultant.
  5. Refer to Section 01 71 23 – Site Engineering for site engineering, site surveying and layout requirements.
2. Existing Conditions: Examine substrates, areas, and condition for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations and perform the following:
  1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  2. Examine roughing in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

3. Examine walls, floors, and roofs for suitable conditions where products and systems will be installed.
4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

1. Provide information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
2. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  1. Notify Owner and Consultant not less than seven (7) working days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Owner's and Consultant's written permission.
3. Take site measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by site measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
4. Verify space requirements and dimensions of items shown diagrammatically on Drawings.

### 3.3 INSTALLATION

1. Locate Work and components of the work accurately, in correct alignment and elevation, as indicated and as follows:
  1. Make vertical work plumb and make horizontal work level.
  2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  3. Conceal pipes, ducts, and wiring in finished areas, unless indicated specifically as being exposed as architectural features:
    1. In rooms or areas having no finished ceiling; pipes, conduits and ducts will generally be left exposed, except where indicated on the Mechanical drawings as built into walls or behind furring. Electrical conduit and fittings shall be built into walls.
    2. In the event of conflicts occurring between equipment shown in concealed areas, the following order of priority shall be observed:
      1. Structural elements.
      2. Plumbing drains.
      3. Sprinkler piping.
      4. Ductwork.
      5. Heating piping.
      6. Plumbing piping.
      7. Electrical conduit.
  4. Maintain minimum headroom clearance of 2440 mm in spaces without a suspended ceiling.
  5. Underside of Structure: Underside of Structure is defined to mean the underside of roof decking or floor slab and as follows:
    1. Horizontal structures supporting roof decking and floor slab are required to penetrate vertical elements and partitions.
    2. Provide sufficient clearance around penetrating components, such as beams, joists, purlins, and similar horizontal components to account for structural deflection and packing of ancillary materials required for the following:



1. Fire Rating.
  2. Smoke Separation.
  3. Acoustic Separation.
  4. Environmental Separation.
  5. Other conditions requiring separation between two adjacent spaces.
2. Install products in accordance with manufacturer's written instructions and recommendations; notify Consultant of any modifications or adjustments to installation requirements where project conditions differ from manufacturer's written instructions.
3. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Performance.
4. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
5. Do not use tools or equipment that produce harmful noise levels unless appropriate Personal Protection Equipment and safety instructions to personnel have been provided:
  1. Notify building occupants and adjacent properties where tools or equipment having harmful noise levels will be in use.
  2. Schedule use of equipment having harmful noise levels at a time that will cause the least disturbance to building occupants and adjacent properties.
6. Be responsible for obtaining manufacturer's literature and for correct roughing-in and hook-up of all equipment, fixtures, and appliances, as required.
7. Inform the Consultant of impending installation of fixtures, switches and attachments and confirm actual locations prior to final installation:
  1. Location of fixtures, apparatus or outlets shown or specified shall be considered as approximate only. The actual location shall be as directed and required to suit conditions at the time of installation as defined by Consultant.
  2. Locations noted on drawings are diagrammatic only.
  3. Note furring requirements and limitations shown on the drawings.
  4. Make allowance for the possibility that indications and locations shown on mechanical and electrical drawings are diagrammatic.
  5. Inform the Consultant before any masonry, concrete forming, or installation work is carried out where the Contractor determines that furring allowances described above cannot be obtained.
8. Inform the Consultant before proceeding with the work where the location of holes in the structure could affect the nature or strength of the structure.

### 3.4 ANCHORS AND FASTENERS

1. Fastenings: Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, and as follows:
  1. Prevent electrolytic action between dissimilar metals and materials.
  2. 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.
  3. Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage.
  4. Wood, or any other organic material plugs are not acceptable; coordinate design of fastenings and anchors with requirements listed below.
  5. Keep exposed fastenings to a minimum, space evenly and install neatly.
  6. Fastenings that cause spalling or cracking of material to which anchorage is made are not acceptable.
  7. Fixings to Steel Decks from Below: Fasten only through bottom flutes.

8. Fixings through Steel Decks from Above: Fasten only through top flutes.
2. Equipment Fastenings: Use fastenings of standard commercial sizes and patterns with material and finish suitable for service, and as follows:
  1. Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
  2. Bolts may not project more than one diameter beyond nuts.
  3. Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.
3. Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work:
  1. Mount components at heights directed by Consultant where mounting heights are not indicated.
  2. Allow for building movement, including thermal expansion and contraction.
4. Anchors for systems, pipes, conduits and equipment, hangers and support systems, and connections to building structure shall be the responsibility of the installing Subcontractor; installing Subcontractor shall retain a professional engineer registered in Province of the Work to review/design anchor installation to ensure that all anchors and attachments to the structure are suitable for the purposes intended, properly installed, including those where installation deviates from design data and standards published by anchor and hanger support manufacturers:
  1. Submit proof of load carrying capacity for standard anchors and hanger supports used in construction when requested by the Consultant or Contractor.
5. Do not use Powder Actuated Tools on site without prior written authorization from Consultant; comply with requirements of the local Occupational Health and Safety Act, General Safety Regulations when powder actuated tools are used.

### **3.5 CONDUIT ON ROOFS AND FLOORS**

1. Electrical conduit and other piping shall not be run on top of roof decks or within concrete toppings of floors, except where specifically shown.
2. Inform Consultant before proceeding where drawings, specifications or job conditions are at variance with this requirement.

### **3.6 JOINTS**

1. Make joints of uniform width. Arrange joints for the best visual effect where joint locations in exposed work are not indicated:
  1. Obtain Consultant's acceptance of joint locations prior to final installation of materials.
  2. Consultant retains the right to adjust location of joints to suit design criteria, provided that adjustment does not affect maximum areas recommended for materials being installed.
  3. Fit exposed connections together to form hairline joints.
2. Do not use products, cleaners, and installation materials that are considered hazardous.

### **3.7 HOUSEKEEPING**

1. Individual Subcontractors will be responsible for daily housekeeping under the Contractor's cleaning program. Subcontractors will provide employees for general clean-up as directed by the Contractor.
2. Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully:

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold materials more than seven (7) days during normal weather or three (3) days if the temperature is expected to rise above 25°C.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
3. Maintain Project site free of waste materials and debris.
4. Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work and safety of personnel in the area:
  1. Remove liquid spills promptly.
  2. Broom clean or vacuum the entire work area, as appropriate, where dust impairs proper execution of the Work.
5. Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property, and that will not damage exposed surfaces.
6. Remove debris from concealed spaces before enclosing the space.
7. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Performance.
8. Clean areas and spaces where cutting and patching are performed; completely remove paint, mortar, oils, putty, and similar materials:
  1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
9. Burying or burning waste materials on site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
10. Clean and protect construction in progress and adjoining materials already in place during handling and installation. Apply protective covering where required to ensure protection from damage or deterioration until Substantial Performance.
11. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
12. Contractor will supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### **3.8 STARTING AND ADJUSTING**

1. Coordinate requirements for starting and adjusting equipment with requirements of Mechanical and Electrical Drawings and Specifications. Implement a starting and adjusting program generally consisting of, but not limited to, the following:
  1. Start equipment and operating components to confirm proper operation
  2. Remove malfunctioning units, replace with new units, and retest
  3. Adjust operating components for proper operation without binding
  4. Adjust equipment for proper operation
  5. Test each piece of equipment to verify proper operation
  6. Test and adjust controls and safeties
  7. Replace damaged and malfunctioning controls and equipment
2. Comply with qualification requirements in Section 01 45 00 – Quality Control where a factory authorized service representative is required to inspect site assembled components and equipment installation.

### **3.9 PROTECTION OF INSTALLED CONSTRUCTION**

1. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Performance.
2. Comply with manufacturer's written instructions for temperature and relative humidity.

### **3.10 CORRECTION OF THE WORK**

1. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Section 01 73 29 – Cutting and Patching:
  1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
2. Restore permanent facilities used during construction to their specified condition.
3. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
4. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
5. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

### **3.11 PROTECTION**

1. Adequately protect Work against possible damage. Carry out specific protection of Work when required by Consultant.
  1. Protect from ground and rainwater.
  2. Protect working surfaces from snow, ice, and frost; remove snow, ice, and frost where necessary for efficient progress.
  3. Protect building works and contents against climatic and weather conditions.
  4. Take all necessary precautionary measures to prevent fire.
2. Any Work damaged by failure to provide protection shall be removed and replaced with new Work at the Contractor's expense.
3. Protect adjacent lanes and private property from damage during construction.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies procedural requirements for cutting and patching required for installation of subsequent work, adjustment to installed work and repairs arising from testing and inspection.

### **1.2 RELATED REQUIREMENTS**

1. Requirements in this Section apply to mechanical and electrical installations; refer to Mechanical and Electrical Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work., and for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

### **1.3 DEFINITIONS**

1. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
2. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Informational Submittals: Provide the following submittals during the course of the work:
  1. Cutting and Patching Proposal: Submit a proposal describing procedures at least ten (10) days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
    1. Extent: Describe cutting and patching, show how they will be performed and indicate why they cannot be avoided.
    2. Changes to Existing Construction:
      1. Describe anticipated results.
      2. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
    3. Products: List products to be used and firms or entities that will perform the Work.
    4. Dates: Indicate when cutting and patching will be performed.
    5. Utilities:
      1. List utilities that cutting and patching procedures will disturb or affect.
      2. List utilities that will be relocated and those that will be temporarily out of service.
      3. Indicate how long service will be disrupted.
    6. Structural Elements: Submit details and engineering calculations showing integration of reinforcement with original structure to the Consultant prior to making cuts or modifications where cutting and patching involve adding reinforcement to structural elements.
    7. Consultant's Acceptance:
      1. Obtain acceptance of cutting and patching proposal before cutting and patching.
      2. Review and acceptance of cutting and patching proposal does not waive right to later require removal and replacement of unsatisfactory work.

### **1.5 QUALITY ASSURANCE**

1. Structural Elements: Do not cut and patch structural elements in a manner that could change their load carrying capacity or load deflection ratio.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety, including but not limited to the following:
  1. Primary operational systems and equipment.
  2. Air or smoke barriers.
  3. Fire protection systems.
  4. Control systems.
  5. Communication systems.
  6. Conveying systems.
  7. Electrical wiring systems.
3. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety, including but not limited to the following:
  1. Water, moisture, or vapour barriers.
  2. Membranes and flashings.
  3. Exterior curtain wall construction.
  4. Equipment supports.
  5. Piping, ductwork, vessels, and equipment.
  6. Noise and vibration control elements and systems.
4. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Consultant's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner. If possible, retain original Installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage original Installer or fabricator, engage another recognized, experienced, and specialized firm, including but not limited to the following:
  1. Processed concrete finishes.
  2. Masonry.
  3. Ornamental metal.
  4. Matched veneer woodwork.
  5. Preformed metal panels.
  6. Roofing.
  7. Firestopping and smoke seals.
  8. Window wall system.
  9. Finished flooring.
  10. Finished coatings.
  11. Wall coverings.
  12. HVAC enclosures, cabinets, or covers.
5. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

## 1.6 WARRANTY

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

## **2 Products**

### **2.1 MATERIALS**

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

## **3 Execution**

### **3.1 EXAMINATION**

1. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed:
  1. Provide investigative methods that use non-ionizing radiation or other approved method to determine locations of existing services and reinforcing in existing concrete slabs and block walls before cutting and renovations.
  2. Advise Consultant of findings before proceeding with the Work and revise penetration locations as required and directed by Consultant.
  3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers before patching.
  4. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

1. Provide temporary support of Work to be cut in accordance with Section 01 50 00 – Temporary Facilities and Controls.
2. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
3. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
4. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to minimize interruption of services to occupied areas.

### **3.3 PERFORMANCE**

1. Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay:
  1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations:
  1. In general, use hand or small power tools designed for sawing and grinding, not hammering, and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond core drill.
  4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
  5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  6. Proceed with patching after construction operations requiring cutting are complete.
3. Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications:
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  2. Exposed Finishes: Restore exposed finishes and extend on to adjoining construction using techniques that completely hide patching and refinishing work.
  3. Floors and Walls:
    1. Patch and repair floor and wall surfaces in the new space where walls or partitions that are removed extend from one finished area into another.
    2. Provide an even surface of uniform finish, colour, texture, and appearance.
    3. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform colour and appearance.
    4. Apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing the patch where patching occurs in a painted surface; provide additional coats until patch blends with adjacent surfaces.
  4. Ceilings: Patch, repair, or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.
  5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. This Section includes requirements associated with Contractor responsibilities associated with ongoing cleaning and site decluttering during the course of the Work and accounts for the following:
  1. Conduct cleaning and disposal operations to comply with all local ordinances and anti-pollution laws.
  2. Store volatile wastes in approved covered containers and remove from premises daily.
  3. Prevent accumulation of wastes which create hazardous conditions.
  4. Provide adequate ventilation during use of volatile or noxious substances.
  5. Cleaning for specific products or work are described in the specification section for that work.
  6. At completion of work Contractor will be required to remove waste materials, rubbish, tools, equipment, machinery, surplus materials, and clean all sight-exposed surfaces.
  7. Leave project clean and ready for Final Cleaning as specified in Section 01 74 23 – Final Cleaning.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 74 19 – Construction Waste Management
  2. Section 01 74 23 – Final Cleaning
  3. Section 01 81 13 – Sustainable Design Criteria
  4. Section 01 81 19 – Construction Indoor Air Quality Requirements

## **2 Products**

### **2.1 MATERIALS**

1. Use only cleaning materials recommended by the manufacturer of the surface to be cleaned, and as recommended by the cleaning material manufacturer.
2. Use only non-toxic cleaning materials and procedures.

### **2.2 CLEANING DURING CONSTRUCTION**

1. The Contractor will designate responsibilities to appropriate Subcontractors to maintain clean work areas on a daily basis to maintain premises free from debris and waste material.
2. Maintain the work site, project grounds and public properties free from litter and accumulations of waste materials and rubbish:
  1. All materials must be stacked neatly and safely.
  2. Do not allow rubbish to accumulate in work under construction or on low roofs.
  3. Upon completion of each Section of Work all debris must be removed from site.
3. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
4. Schedule cleaning operations so that dust or other contaminants resulting from the cleaning process will not fall on wet, newly painted surfaces.
5. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights. Store and transport materials in wheeled containers or on pallets.
6. Take precautions to prevent the disposing of mud or debris on roadways. Any and all such mud or debris shall be cleaned up immediately. Neglect of this requirement will cause the Contractor to have the necessary clean-up work carried out and charge all costs to responsible Subcontractor.

7. Cleaning operations shall include those areas used for temporary site access or used on a temporary basis to facilitate the work.
8. Contractor will direct responsible Subcontractors to deposit their garbage on a daily basis in garbage containers provided; containers will be located on site as directed by Contractor.
9. Failure to maintain housekeeping satisfactory to the Contractor will result in the Contractor arranging for such cleanup as may be required with all related labour and administration costs being charged to responsible Subcontractors.
10. Subcontractors will be expected to participate in a general site clean-up on occasion, as directed by Contractor, working with Contractor and other Subcontractors to clean-up general waste from the interior and exterior areas of the site:
  1. When requested by Contractor, provide one (1) worker for every [ten (10)] of Subcontractor's regular crew (minimum of one (1) worker regardless of crew size).
  2. The frequency and duration of the general clean-up will be as needed and at the discretion of the Contractor.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. Section includes administrative and procedural requirements for the following:
  1. Salvaging nonhazardous demolition and construction waste.
  2. Recycling nonhazardous demolition and construction waste.
  3. Disposing of nonhazardous demolition and construction waste.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 81 13 – Sustainable Design Requirements

### **1.3 DEFINITIONS**

1. Alternative Daily Cover (ADC): Cover material other than soil placed on the surface of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odours, blowing litter, and scavenging.
2. Commingled Waste: Single-stream recycling of material waste, considered as one material waste stream unless diversion rates can be provided by the recycling facility for specific materials.
3. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging. Hazardous materials are not included.
4. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations. Hazardous materials are not included.
5. Disposal: Removal off-site of demolition and construction waste and subsequent deposit in landfill or incinerator acceptable to authorities having jurisdiction.
6. Diversion: To remove, or have removed, from the site for recycling, reuse, salvage, or return of materials that might otherwise be sent to a landfill. Diversion from landfill does not include burning, incinerating, thermally destroying waste, or waste-to-energy processes.
7. Return: To send back reusable or unused products to vendors or manufacturers.
8. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
9. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
10. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.
11. Segregation: To place similar waste materials together for collection in a designated site area, trash bin, or roll-off container.
12. Waste: Waste includes salvageable, returnable, recyclable and reusable material as well as material sent to landfill or incineration facilities. Hazardous materials are not included.

13. **Waste Management Plan:** A project-specific plan for the collection, transportation, recycling, salvage, and disposal of waste generated at the construction site. The purpose of the plan is to ultimately reduce the amount of material that is disposed of in landfills or incineration facilities.
14. **Waste Material Stream:** A flow of materials from a job site into markets for building materials, comprised of a material category (or mixture of several material categories) combined with a diversion method. A material stream must constitute at least five percent (by weight or volume) of total diverted materials for the Project. Examples include source separated materials sent to specific recycling facilities, commingled waste sent to a mixed-waste recycling facility, deconstructed materials sent back to a manufacturer as part of a take-back program, or salvaged materials reused on site.
15. **Waste-To-Energy:** The conversion of non-recyclable waste materials into usable heat and/or fuel through a variety of processes such as combustion, not including the combustion of wood into wood-derived fuel.

#### **1.4 PERFORMANCE REQUIREMENTS**

1. **Project Diversion Goals:** The Owner has established a goal to achieve the following total end-of-Project waste diversion rates (by weight or volume) of total non-hazardous solid waste generated by the demolition and construction Work:
  1. Required: Minimum 75 percent diversion
  2. Target: 90 percent diversion
2. **General:** Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, as applicable to the Work:

#### **1.5 ACTION SUBMITTALS**

1. **Waste Management Plan:** Submit plan within 7 days of date established for the Notice of Award.
  1. Waste generated by on-site workers, such as plastic and metal beverage containers.
  2. All fluorescent lamps, HID lamps, and mercury-containing thermostats removed from the site shall be recycled.
2. **Alternative Daily Cover:** Alternative Daily Cover (ADC) may not be included as diverted material used to meet Project diversion rate goals.
3. **Waste Management Plan:** The Contractor shall be responsible for the development and implementation of a Construction Waste Management Plan for the Project.
  1. **Final Construction Waste Management Plan:** The plan shall contain the following:
    1. Estimate of the total proposed jobsite waste to be generated, including types and quantities.
    2. Proposed alternatives to Landfilling: A list of each material proposed to be salvaged, reused, or recycled during the course of the Project, the proposed destination for each material, and the projected amount (by weight or CY).
    3. Materials handling procedures: A description of the means by which any waste materials identified in Performance Requirements above will be separated (either sorted on-site or commingled on-site and sorted off-site) and protected from contamination, and the means to be employed in recycling the above materials consistent with the requirements for acceptance by recycling processors to be utilized.

4. If waste materials are sorted and separated on-site, include anticipated sizes and quantity of containers, container labeling, and location(s) on the Project site.
  5. List of documentation to be provided in Progress Reports.
  6. Identification of material streams, as defined in the Section.
2. Prior to request for Substantial Completion, provide final approved Waste Management Plan and summary table indicating site-separated waste, by diverted material type, that indicates the total percentage of construction waste diverted from landfill and the identified waste material streams.

## 1.6 INFORMATIONAL SUBMITTALS

1. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit a monthly Waste Management Report including a current Waste Tracking Form. Contractor may use their own Waste Tracking Form format, or a sample form can be provided upon request. Include the following information:
  1. Project title, name of company completing report, and dates of period covered by the report
  2. Report on the disposal of all jobsite waste, including:
    1. Recycled materials. For each material stream, provide the following:
      1. Amount (in tons or cubic yards).
      2. Dates removed from the jobsite.
      3. Receiving Party.
    2. Reused or salvaged materials. For each material stream, provide the following:
      1. Amount (in tons or cubic yards)
      2. Description of intended or actual use
    3. Landfilled materials. Provide the following:
      1. Amount (in tons or cubic yards).
      2. Dates removed from the jobsite.
      3. Identity of the transfer station or landfill.
  4. Gross Total quantity of waste generated during the period.
  5. Include a breakdown of diverted waste for each of the identified waste material streams and major material categories as follows:
    1. Concrete.
    2. Steel or Metals.
    3. Wood.
    4. Gypsum Wallboard.
    5. Crushed Asphalt.
    6. Masonry.
    7. Cardboard.
  6. Provide the quantity of land clearing debris and excavation soil. Note that these categories do not qualify as diverted waste for LEED projects.
  7. Provide the name and location of the recycling or disposal facility that accepted the material.
  8. Provide the percentage of total diverted waste generated as a percentage of total waste for the current period and cumulative project-to-date.

3. Records:
  1. Legible copies of on-site logs, weight tickets and receipts. Receipts shall be from recycling, processing and/or disposal site operators who can legally accept the materials for the purpose of reuse, recycling or disposal.
  2. If mixed construction and demolition waste is sorted off-site, provide a letter from the processor stating the average percentage of mixed C&D waste they recycle. Subcontractor shall save such original documents (as above) for the life of the project plus seven (7) year(s).
  3. Records of salvaged materials donated to charitable organizations. Indicate whether organization is tax-exempt.
4. Waste Reduction Final Report: Submit final report prior to the final Application for Payment.
2. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
  1. Exclude excavation soil, land clearing debris and hazardous material.
  2. Calculations may be performed using either weight or volume but shall be done consistently throughout the duration of the Project. Where exact materials weights or volumes are not available, use the following Conversion Factors, which are acceptable for LEED projects:

1. Cardboard	100 lbs./cu.yd.
2. Gypsum wallboard	500 lbs./cu.yd.
3. Mixed waste	350 lbs./cu.yd.
4. Rubble	1,400 lbs./cu.yd.
5. Steel	1,000 lbs./cu.yd.
6. Wood	300 lbs./cu.yd.
3. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
4. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
5. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
6. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
7. Records of Returns: Indicate receipt and acceptance by vendors or manufacturers who have accepted waste materials as part of their take-back programs. Include receipts.
8. Records of Commingled Waste: If mixed construction and/or demolition waste will be commingled on-site and separated, sorted, and diverted off-site, provide monthly summaries of diversion rates from Recycler/Processor based on one of the following:
  1. Project-specific diversion rate based on actual measurement of each component waste material. Note that visual inspection is not an acceptable method of evaluation for documenting this percentage.

2. If Recycler/Processor provides facility-wide aggregated, annual averaged diversion rates in lieu of Project-specific diversion rates, provide documentation that the Recycler/Processor's method of recording and calculating these rates is regulated by a local or state government authority.
9. LEED Submission: At end of construction submit required documentation for LEED v4 MR pre-requisite Construction and Demolition Waste Management Planning and MR credit Construction and Demolition Waste Management, including:
  1. Completed LEED Online credit forms.
  2. Completed LEED v4 Construction and Demolition Waste Management Calculator (Excel file). The Excel source file can be provided on request or downloaded from <http://www.usgbc.org/resources/construction-and-demolition-waste-calculator>
  3. All required supporting documentation uploaded to LEED Online.
10. Qualification Data: For refrigerant recovery technician (if applicable).
11. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

## 1.7 QUALITY ASSURANCE

1. Waste Management Coordinator Qualifications: Experienced, with a record of successful waste management coordination of projects with similar requirements. LEED-Accredited Professional, certified by the USGBC.
  1. Project LEED Coordinator may serve as the Waste Management Coordinator.
  2. Contractor is responsible for maintaining the LEED Representative throughout the Project duration. If there are staff changes, the Contractor and that that Designated Representatives shall be responsible for transitioning the knowledge base and tracking items to the new Representative.
2. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
3. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
4. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
  1. Review and discuss waste management plan including responsibilities of waste management coordinator.
  2. Review requirements for documenting quantities of each type of waste and its disposition.
  3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
  4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
  5. Review waste management requirements for each trade.
5. Project Meetings: The Waste Management Plan and implementation shall be discussed at the following meetings:

1. Pre-demolition meeting.
2. Pre-construction meeting.
3. Regular job-site meetings.
4. Sub-contractor job-site coordination meetings.

## 1.8 WASTE MANAGEMENT PLAN

1. General: Develop a waste management plan according to ASTM E1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume but use same units of measure throughout waste management plan.
2. Waste Identification: Indicate all anticipated types and quantities of demolition, site clearing, and construction waste generated by the Work, including identifying at least five (5) materials streams targeted for diversion on the Project. Include estimated quantities and assumptions for estimates.
3. Waste Reduction Work Plan: For each waste material stream, list the means of disposal and whether it will be diverted (salvaged, recycled, and/or reused) or sent to landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, identification or receiving facilities, and handling and transportation procedures.
  1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
  2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
  3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
  4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
  5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
  6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.
  7. Alternative Daily Cover: Include a statement affirming that alternative daily cover or other excluded materials were not included in calculations used to meet Project diversion rate goals.

## 1.9 PROJECT MEETINGS

1. Waste management plans and implementation shall be discussed at the following meetings:
  1. Pre-demolition meeting
  2. Pre-construction meeting
  3. Regular job-site meetings
  4. Subcontractor toolbox meetings

## 2 Products

### 2.1 NOT USED



### **3 Execution**

#### **3.1 PLAN IMPLEMENTATION**

1. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
  1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
2. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
3. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
  1. Distribute waste management plan to everyone concerned within three days of submittal return.
  2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
4. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
  2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.
5. Waste Management in Historic Zones or Areas: Hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, by distance determined by the Consultant or more.

#### **3.2 SALVAGING DEMOLITION WASTE**

1. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
  1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
  3. Store items in a secure area until installation.
  4. Protect items from damage during transport and storage.
  5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
2. Salvaged Items for Sale and Donation: Not permitted on Project site, unless otherwise indicated.
3. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
  1. Salvage items indicated on the drawings.
  2. Clean salvaged items.
  3. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

4. Store items in a secure area until delivery to Owner.
  5. Transport items to Owner's storage area off-site, designated by Owner.
  6. Protect items from damage during transport and storage.
- 
4. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
  5. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
  6. Plumbing Fixtures: Separate by type and size.
  7. Lighting Fixtures: Separate lamps by type and protect from breakage.
  8. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

### **3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL**

1. General: Recycle paper and beverage containers used by on-site workers.
2. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to the Contractor.
3. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
4. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
  1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
    1. Inspect containers and bins for contamination and remove contaminated materials if found.
  2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
  4. Store components off the ground and protect from the weather.
  5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

### **3.4 RECYCLING DEMOLITION WASTE**

1. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
2. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
3. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

4. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
5. Metals: Separate metals by type.
  1. Structural Steel: Stack members according to size, type of member, and length.
  2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
6. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
7. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
8. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
9. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.
10. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
  1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
11. Carpet Tile: Remove debris, trash, and adhesive.
  1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
12. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
13. Conduit: Reduce conduit to straight lengths and store by type and size.

### **3.5 RECYCLING CONSTRUCTION WASTE**

1. Packaging:
  1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
  2. Polystyrene Packaging: Separate and bag materials.
  3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
  4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
2. Wood Materials:
  1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
  2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
3. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

### **3.6 DISPOSAL OF WASTE**

1. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
  1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
  2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
2. Burning: Do not burn waste materials.
3. Disposal: Remove waste materials from Owner's property and legally dispose of them.

### **3.7 ATTACHMENTS**

1. LEED v4 Construction and Demolition Waste Management Calculator (sample).

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 45 00 – Quality Control
  2. Section 01 73 00 – Execution
  3. Section 01 77 00 – Closeout Procedures

### **1.2 QUALITY CONTROL**

1. Verify that cleaning agents and methods do not remove finishes and permanent protective coatings on surfaces being cleaned.
2. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average institutional building cleaning and maintenance program.
3. Comply with manufacturer's written or printed cleaning instructions.

### **1.3 COORDINATION**

1. Coordinate repair or replacement of broken or damaged materials with original installing Subcontractors.

## **2 Products**

### **2.1 CLEANING MATERIALS**

1. Use only cleaning materials recommended by manufacturer of material to be cleaned.
2. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

## **3 Execution**

### **3.1 FINAL CLEANING**

1. Conduct cleaning and waste removal operations to comply with local laws and ordinances, Federal and local environmental and antipollution regulations.
2. Complete the following cleaning operations before requesting final review for acceptance of Declaration of Substantial Performance in accordance with Section 01 77 00 – Closeout Procedures, and as follows:
  1. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
  2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
  3. Rake grounds that are not planted or paved to a smooth, even textured surface.
  4. Remove tools, construction equipment, machinery, and surplus material from Project site.
  5. Remove snow and ice to provide safe access to building. Broom clean or remove snow and ice from all exterior paved areas designed for pedestrian or vehicular traffic, including parking areas.
  6. Clean exposed exterior and interior hard surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces.
  7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, interstitial areas, and similar spaces.
  8. Sweep concrete floors broom clean in unoccupied spaces.
  9. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.

10. Clean transparent materials, including mirrors and glass in doors and windows:
  1. Remove glazing compounds and other noticeable, vision obscuring materials.
  2. Replace chipped or broken glass and other damaged transparent materials.
  3. Polish mirrors and glass, taking care not to scratch surfaces.
  4. Restore reflective surfaces to their original condition.
11. Remove labels that are not permanent.
12. Remove protective films from equipment and accessories.
13. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
14. Remove paint from ULC, CSA, WHI and similar labels, including mechanical and electrical nameplates.
15. Wipe surfaces of mechanical and electrical equipment, and similar equipment.
16. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
17. Replace parts subject to unusual operating conditions. Restore equipment, machinery or systems used as temporary facilities to "as-new" condition so that warranties take effect at Substantial Performance.
18. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
19. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
20. Clean ducts, blowers, and coils.
21. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapour fixtures to comply with requirements for new fixtures.
22. Leave Project clean and ready for occupancy.
3. Comply with safety standards for cleaning:
  1. Do not burn waste materials.
  2. Do not bury debris or excess materials on Owner's property.
  3. Do not discharge volatile, harmful, or dangerous materials into drainage systems.
  4. Remove waste materials from Project site and dispose of lawfully.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. Be responsible for starting, testing, adjusting and balancing of piped, ducted, wired and wireless services and systems including all components and equipment forming part thereof; and any other manually and mechanically operated systems including all components and equipment forming a part of the Project.
2. Perform starting of each system and each item of equipment in accordance with the general requirements specified in this Section and is specific to facility start-up and commissioning of the facility.
3. This section specifies additional requirements to those required for normal Contractor's start-up of equipment and systems as contained in the General Requirements of the Contract, and as follows:
  1. Perform and record tests to confirm proper performance and compliance with requirements of Contract Documents; take corrective action as necessary.
  2. Perform adjustments to ensure proper, efficient and safe operation.
  3. Perform balancing to ensure that the various parts of system are in a proper state of equilibrium.
4. Owner's representative will oversee the starting, testing, adjusting and balancing operations, and verify that equipment and systems are working as specified and within manufacturer's operating tolerances.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 32 00 – Schedules
  2. Section 01 75 16 – Startup Procedures
2. Division 08 – Openings:
  1. Section 08 71 00 – Door Hardware

### **1.3 QUALITY ASSURANCE**

1. Perform starting, testing, adjusting and balancing using qualified personnel.
2. Perform starting, testing, adjusting and balancing after starting of equipment and systems.
3. Provide personnel, operate systems at designated times and under conditions required for proper starting, testing, adjusting and balancing.
4. Report to the Consultant any deficiencies or defects noted during starting, testing, adjusting and balancing, which cannot be promptly corrected.

## **2 Products**

### **2.1 MANUFACTURERS' SITE SERVICES**

1. Provide manufacturers authorized representative when specified, or when requested by the Owner at site to do the following:
  1. Inspect, check and approve equipment and systems installation before starting.
  2. Supervise placing equipment and systems in operation.
2. Manufacturers' authorized representative shall provide a written report verifying that equipment:
  1. Is properly installed and lubricated;
  2. Is in accurate alignment;
  3. Is free from any undue stress imposed by connecting lines or anchor bolts; and,
  4. Is being satisfactorily operated under load conditions.

### **3 Execution**

#### **3.1 PREPARATION**

1. Have Contract Documents, shop drawings, product data, and operation and maintenance data at hand during starting process.
2. Coordinate sequence for starting of various equipment and systems.
3. Prepare each system and item of equipment for testing, adjusting and balancing.
4. Verify that each systems and equipment installation is complete and in continuous operation.
5. Verify ambient conditions.

#### **3.2 STARTING**

1. Verify that each item of equipment has been checked for proper lubrication; drive rotation, belt tension, control sequence, and other conditions affecting starting and operation; take corrective action as necessary.
2. Execute starting under supervision of Contractor's personnel and, when specified or requested by Owner, manufacturer's authorized representative.
3. Place equipment and systems in operation in proper sequence and in accordance with approved Contractor's Start-Up sub-schedule.

#### **3.3 TESTING, ADJUSTING, AND BALANCING**

1. Assign Subcontractor responsible for installation of equipment or systems and make them accountable for testing, adjusting and balancing of all:
  1. Piped, ducted, wired and wireless services and systems, including all components and equipment forming part thereof as identified in technical sections, and
  2. Manually and mechanically operated systems including all components and equipment forming part thereof.
  3. Subcontractor shall be aware of and comply with the requirements of all CSA, ASTM, ASHRAE, IEEE and other standards affecting their portion of the work to ensure that systems installed will meet the Owner's testing criteria.
  4. Copies of required standards shall be kept on site during installation and be available for viewing by the Contractor, the Consultant and the Owner.
2. Subcontractor shall perform testing, adjusting and balancing using qualified personnel, or employ and pay for a qualified organization to perform such services.
3. Perform testing, adjusting and balancing after starting of equipment and systems.
4. Provide personnel, operate systems at designated times, and under conditions required for proper testing, adjusting, and balancing.
5. Report to Contractor any deficiencies or defects noted during testing, adjusting and balancing, which cannot be promptly corrected.
6. Subcontractor shall coordinate with the requirements of the Owner's Representative, and requirements for Owner testing, adjusting and balancing listed.

#### **3.4 FINE TUNING**

1. Mechanical and electrical system fine tuning by Subcontractor shall include, but not be limited to, the following:
  1. Air Balancing: final balancing.
  2. Water Balancing: final balancing.
  3. Fire Protection Systems: Verification of fire alarm system.
  4. Electrical Equipment and Systems: Testing of safety systems and devices.
  5. Other systems and equipment as identified in the technical sections.



2. Mechanical and Electrical Subcontractor shall coordinate and cooperate with the Owner's Representative.
3. Mechanical and Electrical Subcontractor shall make necessary adjustments to comply with standards established by the Specifications ready for Owner's formalized verification and commissioning process.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. A facility start-up process shall be used to bring the facility to a fully operational state, free of deficiencies, in the most efficient and timely manner achievable; this process is in addition to the normal procedures for starting equipment and systems required for Declaration of Substantial Performance of the Work.
2. This Section specifies the Subcontractor's and Owner's responsibilities during each of the following successive sub-phases of Facility Start-up:
  1. Equipment and Systems Start-up that leads to Substantial Performance of the Work
  2. Performance Testing will begin after declaration of Substantial Performance as described in Section 01 77 00 – Closeout Procedures and will lead to Fine Tuning of equipment and systems
  3. Fine Tuning will occur after declaration of Substantial Performance as described in Section 01 77 00 – Closeout Procedures and will lead to Final Acceptance of the Work

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 75 13 – Checkout Procedures
  2. Section 01 77 00 – Closeout Procedures
  3. Section 01 79 00 – Demonstration and Training

### **1.3 QUALITY ASSURANCE**

1. Test and Balance Agency Qualifications: Provide proof of qualifications and list of personnel proposed for use on the project during the course of work and prior to starting any work of this Section.
2. Personnel: Testing agency must employ Test and Balance Technicians certified in accordance with the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB) for the type of testing and balancing work undertaken by individual technicians.
3. Testing Agency: Engage a Testing Agency that is a member in good standing of the AABC, NEBB or both and that employs at least one certified Test and Balance Engineer responsible for oversight for review and certifying test and balance reports, providing supervision of Test and Balance Technicians, and who has a successful record of experience in work of similar extent and complexity as required for this project.

## **2 Products**

### **2.1 NOT USED**

## **3 Execution**

### **3.1 FACILITY START-UP**

1. Subcontractor will do the following during Facility Start-up, not necessarily in order listed:
  1. Start equipment and systems as specified in Section 01 75 13 – Checkout Procedures.
  2. Test, adjust and balance equipment and systems as specified in Section 01 75 13 – Checkout Procedures.
  3. Demonstrate equipment and systems as specified in Section 01 79 00 – Demonstration and Training.
  4. Complete and submit Facility Start-up report forms including:
    1. Subcontractor's system and equipment start-up reports.
    2. Testing, adjusting and balancing reports.
    3. Manufacturers' equipment start-up reports

5. Review Contract Documents and inspect the Work to ensure completeness of the Work and compliance with requirements of Contract Documents.
  6. Correct Contract Deficiencies identified as a result of the foregoing and as may be identified by the Owner.
  7. Execute Change Orders issued by the Owner.
  8. Perform all other work and activities required for fulfillment of prerequisites to Substantial Performance of the Work as specified in Section 01 77 00 – Closeout Procedures.
2. Owner will do the following during Facility Start-up:
    1. Carry out Interim Reviews as necessary.
    2. Witness manufacturers' equipment start-up.
    3. Verify starting, testing, adjusting and balancing by Contractor.
    4. Review and approve Facility Start-up reports.
    5. Cooperate in systems and equipment demonstration and instruction.
    6. Initiate Change Orders as required.
    7. Verify correction of Contract Deficiencies by Contractor.
    8. Verify execution of Change Orders by Contractor.
    9. Perform other activities related to Substantial Performance of the Work as specified in Section 01 77 00 – Closeout Procedures.
  3. The preceding requirements will be conducted in an ongoing cycle of:
    1. Owner's inspections.
    2. Documentation of results.
    3. Diagnosis of problems.
    4. Correction of Contract Deficiencies and execution of Change Orders as required.
    5. Verification of results.

### 3.2 PERFORMANCE TESTING

1. Performance Testing will commence upon Substantial Performance of the Work.
2. Owner will do the following during Performance Testing:
  1. Carry out a series of pre-planned systems and equipment operating tests under conditions simulating, to the extent possible, full and partial operating loads.
  2. Record test results.
  3. Diagnose problems and determine whether they are the result of Contract Deficiencies.
  4. Initiate Change Orders as required.
  5. Repeat tests as required following correction of Contract Deficiencies and execution of Change Orders by Contractor and verify results.
  6. Perform other activities related to Total Performance of the Work as specified in Section 01 77 00 – Closeout Procedures.
3. Contractor shall do the following during Performance Testing:
  1. Correct Contract Deficiencies previously outstanding and those identified during Performance Testing.
  2. Execute Change Orders issued by the Owner.
4. The preceding requirements will be conducted in an ongoing cycle of:
  1. Performance testing.
  2. Documentation of results.
  3. Diagnosis of problems.
  4. Correction of Contract Deficiencies and execution of Change Orders as required.
  5. Verification of results.

### **3.3 FINE TUNING**

1. Fine Tuning shall commence upon Owner's acceptance of Performance Testing results.
2. Contractor shall do the following during Fine Tuning:
  1. Correct all Contract Deficiencies previously outstanding and those identified during Fine Tuning.
  2. Execute Change Orders issued by Owner.
  3. Perform all other work and activities required for fulfillment of prerequisites to Final Acceptance of the Work as specified in Section 01 77 00 – Closeout Procedures.
3. Owner will do the following during Fine Tuning:
  1. Conduct user surveys and take environmental measurements as necessary to identify existing and potential problems.
  2. Initiate Change Orders as required.
  3. Perform other activities related to Final Acceptance of the Work as specified in Section 01 77 00 – Closeout Procedures.

### **3.4 SEASONAL CONSTRAINTS**

1. Notwithstanding all inclusive requirements specified in this Section, additional separate cycles of Facility Start-up, Performance Testing and Fine Tuning may be necessitated at a later time on equipment and systems whose full operation is dependent on seasonal conditions.
2. Contractor's responsibilities with respect to such later Facility Start-up activities shall be as specified in this Section.

### **3.5 PARTIAL UTILIZATION OF WORK**

1. Applicable requirements specified in this Section shall apply to the parts of the Work being utilized when partial utilization of the Work is required.

### **END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specified administrative and procedural requirements for contract closeout, which will be conducted in accordance with a specific take-over process as follows:
  1. Preparation of deficiency list by Contractor.
  2. Preliminary review by Consultant and confirmation of deficiency list
  3. Interim procedures:
    1. Submission of warranties.
    2. Submission of record drawings.
    3. Submission of operations and maintenance manuals.
    4. Submission of maintenance materials and equipment.
    5. Submission of certificates required by Consultant.
    6. Instructions to Owner and Owners personnel.
    7. Completion of final cleaning.
    8. Submission of final construction photographs.
    9. Submission of deficiency list indicating items completed, and items outstanding.
  4. Declaration of Substantial Performance of the Work:
    1. Review and acceptance by Consultant prior to publishing of Contractor's Declaration of Substantial Performance.
    2. Submittal of Declaration of Substantial Performance of the Work in accordance with Construction Act (Ontario) signifying that:
      1. Project is ready for takeover by the Owner.
      2. Application for Final Payment is completed; and,
      3. Commencement date for warranty obligations under the Contract has started.
    3. Administration of Lien Fund and other holdback amounts.

### **1.2 RELATED REQUIREMENTS**

1. Refer to individual Technical Sections for specific requirements for instruction to Owner's personnel and for specific closeout and special cleaning requirements for products of those Sections.

### **1.3 REFERENCE STANDARDS**

1. Ontario Association of Architects (OAA) / Ontario General Contractors Association (OGCA):
  1. OAA/OGCA Document 100, OAA/OGCA Take-Over Procedures

## **2 Products**

### **2.1 DEFICIENCY LIST**

1. Contractor and all Subcontractors shall perform inspections of the Work, identify deficiencies and defects, and repair all such deficiencies and defects as necessary in conformance with the Contract Documents.
2. Prepare a list of all incomplete items and submit three (3) copies of list to Consultant prior to declaring Substantial Performance. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed that are outside the limits of construction:
  1. Organize a listing of areas and spaces in sequential order.
  2. Organize items that are applicable to each space by major element, including categories for ceiling, individual walls, floors, equipment, building systems and other components.
  3. Include the following information at the top of each page:

1. Project Name.
  2. Date of Review.
  3. Name of Owner.
  4. Name of Consultant.
  5. Name of Contractor.
  6. Page number and number of pages (i.e., Page 1 of 5).
4. Include and accurate value of items on the list and identify reasons why the item of work remains incomplete or deficient.
  5. Include space for Consultant's verification check and any additional items that the Consultant may need to add during preliminary review.
  6. Include space for Contractor's corrective action and anticipated Completion Date.
  7. All lists must be prepared on Contractor's letterhead.

### **3 Execution**

#### **3.1 PRELIMINARY REVIEW**

1. Consultant will conduct a preliminary review subsequent to receiving deficiency; the Consultant may, at their sole discretion, list additional items arising from preliminary review.
2. Modifications to the deficiency list will be reviewed and discussed with the Contractor. Contractor will be requested to update list to accurately reflect all changes or modifications arising from preliminary review.

#### **3.2 INTERIM PROCEDURES**

1. Prior to requesting final review, the Contractor shall undertake the following items in preparation for declaration of Substantial Performance:
  1. Submit a written certificate to Consultant that the following have been performed:
    1. Work has been completed and inspected for compliance with Contract Documents.
    2. Contractor's start-up of equipment and systems, functioning within normal operating parameters.
    3. Defects have been corrected and deficiencies have been completed.
    4. Equipment and systems have been tested, adjusted, and balanced and are fully operational.
    5. Certificates required by Boiler Inspection Branch, Fire Commissioner and utility companies and all other authorities having jurisdiction have been submitted.
    6. Completed Operation and Maintenance Data Manuals have been submitted to Consultant.
    7. Record Drawings and Specifications have been completed and submitted to Consultant.
    8. Operation of systems have been demonstrated to Owner's personnel.
    9. Work is complete and ready for Final Review.
    10. Witnessed test results and list of attendees.
  2. Provide or complete the following items for the Owner prior to declaration of Substantial Performance:
    1. Advise Owner of pending insurance changeover requirements.
    2. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
    3. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
    4. Prepare and submit Project Record Documents, operation and maintenance manuals, final construction photographs, damage or settlement surveys, property surveys, and similar final record information.

5. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
6. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
7. Complete start-up testing of systems.
8. Submit testing, adjusting and balancing records.
9. Terminate and remove temporary facilities from Project site, along with mock-ups not forming a part of the final construction, construction tools, and similar elements.
10. Advise Owner of changeover in heat and other utilities.
11. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
12. Complete final cleaning requirements, including touch-up painting.
13. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

### 3.3 FINAL REVIEW

1. Request final review only when the Work identified in deficiency list noted as incomplete has been completed or corrected in its entirety. The Consultant and Contractor will perform a final review of the Work.
2. Results of completed review will form the basis of Consultant's acceptance of Certificate of Substantial Performance.
3. Should the Consultant determine that an excessive number of deficiencies exist, the final review will cease and the Contractor shall re-start the declaration procedure.
4. Should the Consultant consider that the Work is substantially performed:
  1. Consultant will issue a Letter of Acceptance of Contractor's Certificate of Substantial Performance which will contain:
    1. Acceptance of date for Substantial Performance.
    2. List of items to be completed or corrected.
    3. The time within which the Contractor shall complete or correct the Work of listed items.
    4. The amount of the holdback for deficiencies will be a minimum of 200% of the estimated cost to correct the deficiencies.
  5. Signature of:
    1. Consultant.
    2. Subconsultants.
    3. Contractor.
    4. Owner.

### 3.4 FINAL PAYMENT

1. Following completion of lien period, submit claim for final payment in accordance with General Conditions.
2. Submit certified copy of inspection list of items to be completed or corrected, endorsed, and dated by Consultant. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

### 3.5 FINAL ACCEPTANCE

1. Final acceptance of the Work will occur after completion of Performance Testing and Fine Tuning required by Section 01 75 16 – Start-up Procedures.

## END OF SECTION

## **1 General**

### **1.1 SUMMARY**

1. An organized compilation of operating and maintenance materials and data including, but not necessarily limited to, the following:
  1. Detailed technical information.
  2. Documents and records clearly and accurately describing operation and maintenance of individual products, items, components, and systems as specified in individual technical sections of Divisions 02 through 49.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 33 00 – Submittal Procedures
  2. Section 01 77 00 – Closeout Procedures
  3. Section 01 78 39 – Project Record Documents
2. Division 20 – Mechanical Support
3. Division 26 – Electrical

### **1.3 ADMINISTRATION REQUIREMENTS**

1. Approvals Process: Submit two (2) digital copy drafts of Operation and Maintenance Manuals to Consultant for review and distribution to Consultant for approval:
  1. Submission of individual operation and maintenance data will not be accepted; only complete Manuals will be reviewed.
  2. Allow a minimum of four (4) weeks for Consultant to review and approve Operation and Maintenance Manuals; make requested changes before submitting final hard and electronic copies.
  3. Completion and final acceptance by Consultant of Operation and Maintenance Manuals is a prerequisite for declaration of Substantial Performance.
2. Coordination: Coordinate work of this Section with related requirements and contents of Technical Specifications and allow sufficient time for preparation of manuals, Consultant's review and approval procedures, corrections by individual contributors to the manual and date of Substantial Performance.

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Provide the following submittals to Consultant not less than fourteen (14) working days prior to application for Substantial Performance:
    1. Operation and Maintenance Manuals:
      1. Final Electronic Version: Provide one (1) copy of manufacturer's maintenance manuals and operational schematics scanned or native format PDF on USB Flash Drive.
      2. Final Paper Version: Provide one (1) copy of manufacturer's maintenance manuals and operational schematics, bound as specified in this Section.



## 2 Products

### 2.1 OPERATION AND MAINTENANCE MANUALS

1. Assemble, coordinate, bind and index all required data into Operation and Maintenance Manual arranged by the same MasterFormat Division numbers and titles used for the project, and as follows:
  1. Submit required copies in the English language as established by the Contract.
  2. Type all lists and notes; handwritten information will not be acceptable.
  3. Drawings, diagrams, and manufacturers literature must be legible.
2. Electronically Bound: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required, and as follows:
  1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning paper documents, configure scanned files for minimum readable file size.
  2. File Names and Bookmarks: Bookmark individual documents based on MasterFormat Division number and titles used for the project.
  3. Name document files to correspond to subgroups and divisions used in project manual and table of contents. Group documents for each system and subsystem into individual composite bookmarked files.
  4. Configure electronic manual to display bookmark panel upon file opening.
3. Binders: Submit manuals in paper format compiled in binders as noted after electronically submitted manuals are fully reviewed and accepted by Consultant, and as follows.
  1. "D" ring type, heavy duty vinyl binders having clear plastic pockets on the spine and front cover for project information inserts.
  2. Limit binder size to a maximum of 75 mm and no more than 2/3 full.
  3. Label each division and section with tabs protected with celluloid covers fastened to hard paper dividing sheets.
  4. Binder Colours:
    1. Architectural: Black.
    2. Structural: Yellow.
    3. Mechanical: Green.
    4. Electrical: Royal Blue.
    5. Shop Drawings: Red.

## 3 Execution

### 3.1 ASSEMBLY OF MANUALS

1. Architectural Manuals: Coordinate requirements of Architectural binders with specific requirements contained in the Technical Specifications; include cover sheets identifying:
  1. Date submitted
  2. Project title, location, and project number
  3. Names and addresses of Contractor and all Subcontractors
  4. Table of Contents of all binder volumes and disciplines.
  5. List of warranties and guaranties for the project.
  6. List of approvals and certificates for the project.
2. Structural, Mechanical, and Electrical Binders: Coordinate contents of mechanical and electrical binders with operation and maintenance manual requirements listed in Division 20 and Division 26; include cover sheets identifying:
  1. Date submitted.
  2. Project title, location, and project number.
  3. Names and addresses of Contractor and Subcontractors contributing to contents of individual mechanical and electrical binders.

4. Table of Contents of individual mechanical and electrical binder volumes.
  5. List of warranties and guaranties contained in the individual mechanical and electrical binders.
  6. List of approvals and certificates contained in the individual mechanical and electrical binders.
3. Shop Drawings Manuals: Coordinate contents of shop drawing binders with submission requirements listed in the Technical Specifications:
    1. Date submitted.
    2. Project title, location, and project number.
    3. Names and addresses of Contractor and Subcontractors contributing to contents of shop drawing binder.
    4. Table of Contents of individual shop drawings cross referenced to Architectural, Mechanical and Electrical binder locations.
    5. Bind one complete set into a clear plastic sleeve of reviewed final shop drawings and product data.
  4. Material, Product or System Data: Include the following listing of information for each individual tab within the Operation and Maintenance Manuals:
    1. Tab Contents:
      1. Vendor name.
      2. Equipment make, model, and serial number.
    2. Spare parts lists:
      1. Source of spare parts for materials that are not kept at site
      2. List of spare parts that are required to be kept at site
    3. Warranty or Guaranty information and claim procedure specific to material, product, or system.
    4. Operation Data: Description of each system and its controls and as follows:
      1. Control schematics for each system including environmental controls
      2. Description of operation of each system at various loads together with reset schedules and seasonal variances
      3. Operation instruction for each system and each component
      4. Description of actions to be taken in event of equipment failure
    5. Maintenance Data: Servicing, maintenance, operation and troubleshooting instructions for each item of equipment and as follows:
      1. Maintenance schedules with tasks and frequencies including listing of tools required to complete maintenance and estimated task time
    6. Performance Data: Equipment manufacturer's performance data sheets with point of operation as left after facility systematic testing and balancing was completed including the following:
      1. Equipment performance verification test results
      2. Special performance data as specified in individual Technical Specification Sections
  5. Index of Operation and Maintenance Manuals: Include an index based on Systems that cross reference the MasterFormat Division, Number and Title, and Volume including but not limited to, the following:
    1. Include equipment as specified in mechanical and electrical specification sections.

6. Additional Data: Prepare and insert additional information that becomes apparent during demonstration and instructions to owner when it is evident that operations and maintenance information is insufficient or requires clarification.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for administrative and procedural requirements for managing project record documents described in this Section.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 26 10 – Request for Information Procedures
  2. Section 01 33 00 – Submittal Procedures
  3. Section 01 35 73 – Delegated Design Procedures
  4. Section 01 45 00 – Quality Control
  5. Section 01 73 00 – Execution
  6. Section 01 77 00 – Closeout Procedures
  7. Section 01 81 13 – Sustainable Design Criteria

### **1.3 DEFINITIONS**

1. Record Documents: Record Documents consist of Divisions 01 to 49 forming the Specifications contained in the Project Manual and Drawings issued for Bid as modified by subsequent addenda, bid revisions, contract modification documents, and change orders and can also include:
  1. Responses issued by Consultant to the Contractor's requests for interpretation described in Section 01 26 10 – Request for Information Procedures.
  2. Modifications contained in addenda, bid revisions and change orders issued during the performance of the Work.
  3. Information submitted by the Contractor for the Consultant's review including shop drawings, product data and other documents required by Section 01 33 00 – Submittal Procedures.
  4. Information obtained from Contractor's design solutions and reviewed by the Consultant as described in Section 01 35 73 – Delegated Design Procedures.
  5. Operations and maintenance information and other project closeout information including start-up, testing and balancing reports, and commissioning reports described in Section 01 77 00 – Closeout Procedures and Section 01 78 23 – Operation and Maintenance Data.
2. As-Built Drawings: Drawings prepared and updated by the Contractor throughout the Work, indicating a compilation of construction changes indicated in the original Contract Documents, such as, the following:
  1. Actual locations of installed building components and fabrications resulting from changes to dimensions, elevations or orientation,
  2. Modifications to construction location that are different than locations indicated on Contract Documents, or
  3. Changes resulting from adjustments during commissioning operations.

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Source Documents: Consultant will provide digital copies of Drawings and Specifications for Contractor's use in preparation of As-Built Drawings after award of Contract and a minimum of 30 days before required use as Project Record Documents.
2. Designation of Project Record Documents: Contractor will use the following Project Record Documents:
  1. Primary As-Built Drawing Set: Digital copy of Drawings and Specifications that serves as the Contractor's official As-Built Drawing.

2. Additional As-Built Drawing Sets: Additional sets of Drawings and Specifications required by the Contractor to allow for coordination between Subcontractors.
3. Addenda and Bid Revisions: Digital copy of Bid Document modifications issued during bid period.
4. Contract Changes: Digital copy of Site Instructions, Change Directives and Change Orders issued during construction.

### 1.5 SUBMITTALS

1. As-Built Drawing Authentication: Contractor will prepare a signed statement indicating that; to the best of their knowledge, information contained on the As-Built Drawings accurately reflects modification to the Work as prepared by the Contractor, including information incorporated from As-Built Drawings prepared by their Subcontractors.

## 2 Products

### 2.1 NOT USED

## 3 Execution

### 3.1 PREPARATION OF AS-BUILT DRAWINGS

1. As-Built Drawing Content: Contractor will develop and maintain As-Built Drawings for the duration of the Work and include the following content:
  1. Actual installation conditions, differing site conditions and obstructions encountered on site;
  2. Deviations from Contract Documents including changes associated with coordination of components not managed by change modification documents or site instructions;
  3. Contract modifications managed by change directives or change orders;
  4. Official responses to RFIs prepared by the Consultant;
  5. Direction provided by Consultant arising from site instructions;
  6. Design solutions that are the responsibility of the Contractor in accordance with Section 01 35 73 – Delegated Design Procedures;
  7. Modifications arising from coordination between different parts of the Work not otherwise identified through formal contract modifications, site instructions or the RFI process.
2. Recording Modifications to Contract Documents: Update Contract Documents regularly during the Work to maintain accurate and complete As-Built Drawings as follows:
  1. Use same scale as used in the Contract Documents when adding details to As-Built Drawings;
  2. Cross out words such as “equal to” or “similar to” and replace with specific references used to describe the modified component of Work;
  3. Cross out original numeric values in dimension strings, elevations and offsets and add corrected numeric values in close proximity to original numbers;
  4. Indicate actual lines and levels, depths and grades of piping, conduit and utilities indicated schematically on Contract Documents;
  5. Add or replace drawing sheets using same size, scale and format as original drawing sheets, identify original drawing sheets being replaced with large and prominent X spanning from border-to-border;
  6. Incorporate change modifications as complete detail so that As-Built Drawings act as a standalone package, simple referencing of change modification numbers is not acceptable;
  7. Prepare fully written notes and descriptions of changes, with clear and legible lettering, shorthand and undefined abbreviations are not acceptable;
  8. Incorporate full extent of modification between related plans, sections and details, general and keynotes, profiles and schedules using lettering and terminology consistent with the Contract Documents; and
  9. Include references to shop drawings and product data as an appendix to As-Built Drawings, with clearly described references between original Contract Documents and appendix content.

3. Identification of As-Built Drawing Changes: Identify changes using three base colours as follows:
  1. Red: Deleted Items;
  2. Green: Added Items; and
  3. Blue: Supplementary or special information or supplementary details.
4. Completion of As-Built Drawings: Add the following notes to the final As-Built Drawings before submitting to Owner:
  1. Update drawing index identifying sheets with modifications or that were added to the original listing of Contract Documents; and
  2. Mark title block of each sheet with "AS-BUILT DRAWING" with Contractor's name, date of drawing issue and the following:
    1. Include a note "No Changes" for sheets that have not been changed or contain no mark-ups;
    2. Include a note "Revised" for sheets containing changes and mark-ups; and
    3. Include a note "Additional" for new sheets added to the As-Built Drawings.
5. Availability for Review: Make As-Built Drawings available for review during site meetings, with information updated before application for monthly progress payments, and as follows:
  1. Require Subcontractors to record modifications to their respective Work a minimum of once a week
  2. Update Contractor's As-Built Drawings with Subcontractors content before application for progress payment.
  3. Submit completed As-Built Drawings concurrently with application for Substantial Performance of the Work.

### **3.2 CONSULTANT'S REVIEW OF AS-BUILT DRAWINGS**

1. Consultant's review of As-Built Drawings does not represent a verification of the accuracy or completeness of the As-Built Drawings; responsibility for accuracy lies solely with the Contractor:
  1. The Owner reserves the right to verify or survey as-built conditions using an independent agency where subsequent reviews or modifications to the Work occur during the Warranty Period and that indicate As-Built Drawing contain inaccuracies.
  2. Contractor will be held responsible for costs of independent survey agency and costs related to revisions to the Record Documents where inaccuracies are contained within the Record Documents.

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Divisions 02 through 49 of the Project Manual for individual products or systems as specified in individual sections and not otherwise listed in this Section.

### **1.2 QUALITY ASSURANCE**

1. Source of Supply: Provide spare parts manufactured by original equipment manufacturer and that are identical to those installed.

### **1.3 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver required items to the Place of the Work and store in temporary locations determined by Contractor or permanent locations designated by Owner; in original factory packaging or other securely packaged form.
2. Storage and Handling Requirements: Identify, on carton or package, name of item, colour or part number, as applicable. Identify equipment, system, area, room number and other unique identifier for which each item is intended, and as follows:
  1. Maintain an inventory list of all items delivered. For each item, record description of item, quantity, and location where stored.
  2. Stored items shall remain in Contractor's care, custody, and control until Substantial Performance of the Work. Protect stored items against theft or damage.
  3. Handle items as necessary, until stored in permanent locations designated by Owner.

## **2 Products**

### **2.1 NOT USED**

## **3 Execution**

### **3.1 ACCEPTANCE**

1. Prior to requesting Owner's inspection for Substantial Performance of the Work, do the following:
  1. Review Contract Documents and compare with inventory list to verify that all required items have been delivered.
  2. Verify that items listed on inventory list are in their designated storage locations.
  3. Inspect items to verify that they meet specified requirements and are in serviceable condition.
  4. Arrange for delivery of any missing items.
  5. Arrange for replacement of items not meeting specified requirements or not in serviceable condition.
  6. Provide Owner with copy of inventory list indicating status of all required items.
2. Review inventory list with Owner during review for Substantial Performance of the Work.
3. Provide a duplicate copy delivery slip and obtain Owner's signature upon delivery for items not delivered prior to Substantial Performance of the Work; Owner will only accept responsibility for care, custody, and control of items properly received and signed for.

### **3.2 SCHEDULE**

1. Provide spare parts and maintenance materials specified in the technical specification Sections.
2. Provide maintenance materials in whole pieces, boxed and packaged in original wrapping or wrapped and identified for material and location within the building.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specified administrative and procedural requirements for instructing Owner's personnel, including the following:
  1. Demonstration of operation of systems, subsystems, and equipment.
  2. Training in operation and maintenance of systems, subsystems, and equipment.
  3. Demonstration and instruction videos.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements
  1. Section 01 31 19 – Project Meetings
  2. Section 01 77 00 – Closeout Procedures
  3. Section 01 78 23 – Operation and Maintenance Data
  4. Section 01 91 13 – General Commissioning Requirements
2. Specific requirements for demonstration and instruction for products listed in individual technical specification sections contained in the Project Manual.

### **1.3 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate instruction schedule with Owner's operations; adjust schedule as required to minimize disrupting Owner's operations and as follows:
  1. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
  2. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals; do not submit instruction program until operation and maintenance data has been reviewed and accepted by the Consultant.
  3. Coordinate individual presentations and ensure representatives scheduled to present at seminars are in attendance.

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Submit two (2) copies of outline of instructional program for demonstration and instruction, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module:
    1. Include learning objective and outline for each training module.
  2. Submit qualification data for facilitator or instructor.

### **1.5 PROJECT CLOSEOUT SUBMISSIONS**

1. Provide operations and maintenance information in accordance with Section 01 78 23 – Operation and Maintenance Data.
2. Submit attendance record for each training module, submit list of participants and length of instruction time.
3. Submit evaluations for each participant and for each training module, submit results and documentation of performance-based test.
4. Submit one (1) complete training manuals for Owner's use at completion of training.
5. Submit two (2) demonstration and instruction videos within seven (7) working days after the end of each training module.



6. Identify each copy of training manuals and videos with an applied label containing the following information:
  1. Name of Project.
  2. Name of Consultant.
  3. Name of Contractor.
  4. Name and address of videographer where applicable.
  5. Date video was recorded.
  6. Description of vantage point, indicating location, direction by compass point, and elevation or storey of construction that videos were made.
7. Include a transcript of video training modules prepared on nominal 215 mm x 280 mm paper for inclusion in appropriate section of completed training manuals, containing same label information as the corresponding video.

#### **1.6 QUALITY ASSURANCE**

1. Facilitator shall be a company or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
2. Instructor shall be a factory authorized service representative, qualified by the manufacturer and experienced in operation and maintenance procedures and training.
3. Videographer shall be a professional photographer who is experienced photographing construction projects and training sessions.
4. Conduct a Pre-Instruction Conference in accordance with Section 01 31 19 – Project Meetings to review methods and procedures related to demonstration and instruction.

### **2 Products**

#### **2.1 PREPARATION OF AGENDAS AND OUTLINES**

1. Prepare agendas and outlines including the following:
  1. Equipment and systems which will be included in seminars
  2. Name of companies and representatives presenting at seminars
  3. Outline of each seminar's content
  4. Time and date allocated to each system and item of equipment

#### **2.2 PROGRAM STRUCTURE**

1. Develop a learning objective and teaching outline for each training module, that shall include the following minimum instruction requirements:
  1. Description of specific skills and knowledge that participants are expected to master
  2. System, subsystem, and equipment descriptions
  3. System design and operational philosophy if Subcontractor is delegated design responsibility, including the following:
    1. An overview of how system is intended to operate.
    2. Description of design parameters, constraints and operational requirements
    3. Description of system operation strategies
  4. Regulatory requirements
  5. Equipment function
  6. Operating characteristics
  7. Limiting conditions
  8. Performance curves

9. Documentation:
  1. Emergency manuals
  2. Operations manuals
  3. Maintenance manuals
  4. Project Record Documents
  5. Identification systems
  6. Warranties and bonds
  7. Maintenance service agreements and similar continuing commitments
10. Emergencies:
  1. Instructions on meaning of warnings, trouble indications, and error messages
  2. Instructions on stopping
  3. Shutdown instructions for each type of emergency
  4. Operating instructions for conditions outside of normal operating limits
  5. Sequences for electric or electronic systems
  6. Special operating instructions and procedures
11. Operations:
  1. Start-up procedures
  2. Equipment or system break-in procedures
  3. Routine and normal operating instructions
  4. Regulation and control procedures
  5. Control sequences
  6. Safety procedures
  7. Instructions on stopping
  8. Normal shutdown instructions
  9. Operating procedures for emergencies
  10. Operating procedures for system, subsystem, or equipment failure
  11. Seasonal and weekend operating instructions
  12. Required sequences for electric or electronic systems
  13. Special operating instructions and procedures
12. Adjustments:
  1. Alignments
  2. Checking adjustments
  3. Noise and vibration adjustments
  4. Economy and efficiency adjustments
13. Troubleshooting:
  1. Diagnostic instructions
  2. Test and inspection procedures
14. Maintenance:
  1. Inspection procedures
  2. Types of cleaning agents to be used and methods of cleaning
  3. List of cleaning agents and methods of cleaning detrimental to product
  4. Procedures for routine cleaning
  5. Procedures for preventive maintenance
  6. Procedures for routine maintenance
  7. Instruction on use of special tools
15. Repairs:
  1. Diagnosis instructions
  2. Repair instructions

3. Disassembly; component removal, repair, and replacement; and reassembly instructions:
  1. Instructions for identifying parts and components
  2. Review of spare parts needed for operation and maintenance
2. Present information dealing with equipment, including the following in presentations:
  1. Explanation of how equipment operates.
  2. Recommended preventative and routine maintenance.
3. Develop individual training modules for each system and equipment not part of a system, as required by individual specification sections, and as follows:
  1. Motorized doors, including overhead coiling doors and automatic entrance doors
  2. Equipment, including projection screens, service equipment, and appliances.
  3. Fire protection systems, including fire alarm, fire pumps and fire-extinguishing systems; refer to Division 21 for additional requirements.
  4. Intrusion detection systems.
  5. Heat generation equipment including, but not limited to, boilers, feed water equipment pumps, steam distribution piping and water distribution piping; refer to Division 23 for additional requirements.
  6. Refrigeration systems including, but not limited to, chillers, cooling towers, condensers pumps, and distribution piping; refer to Division 23 for additional requirements
  7. HVAC systems including, but not limited to, air handling equipment, air distribution systems and terminal equipment and devices; refer to Division 23 for additional requirements
  8. HVAC instrumentation and controls; refer to Division 25 for additional requirements
  9. Electrical service and distribution including, but not limited to, transformers, switchboards panel boards, uninterruptible power supplies, and motor controls; refer to Division 26 and 27 for additional requirements
  10. Packaged engine generators, including transfer switches; refer to Division 26 for additional requirements
  11. Lighting equipment and controls; refer to Division 26 for additional requirements
  12. Communication systems including, but not limited to, intercommunication, surveillance clocks and programming, voice and data, and television; refer to Division 27 for additional requirements

### **3 Execution**

#### **3.1 PREPARATION**

1. Assemble educational materials necessary for instruction, including documentation and training module.
2. Assemble training modules into a combined training manual.
3. Set up instructional equipment at instruction location.

#### **3.2 INSTRUCTION**

1. Training Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor, Subcontractor and Owner for number of participants, instruction times, and location.
2. Scheduling: Provide instruction at mutually agreed on times; provide similar instruction at start of each season for equipment that requires seasonal operation:
  1. Schedule training with Owner, through Consultant with at least seven (7) working days advance notice.
3. Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system as follows:

1. Provide instructors experienced in operation and maintenance procedures who can present the following:
  1. Explain equipment operation
  2. Starting and stopping procedures
  3. Preventative and routine maintenance procedures
2. Provide instruction at mutually agreed on times.
3. Provide similar instruction at the start of each season for equipment that requires seasonal operation.
4. Arrange for presentation leaders familiar with the design, operation and maintenance, and troubleshooting of the equipment and systems.
5. Where a single person is not familiar with aspects of the equipment or system, arrange for specialists familiar with each aspect.
4. Demonstrate operation of equipment and systems. Include the following in demonstration:
  1. Start up and shut down
  2. Operation
  3. Scheduled and preventative maintenance
  4. Troubleshooting
  5. Demonstration may be conducted at time of original starting with Owner's prior approval
5. Demonstration and instruction questions:
  1. Be prepared to answer questions raised by Owner at demonstrations and seminars.
  2. If unable to satisfactorily answer questions immediately, provide written response within three (3) working days.
6. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written or demonstration performance-based test.
7. Cleanup:
  1. Collect used and leftover educational materials and turnover to Owner for their use.
  2. Remove instructional equipment.
  3. Restore systems and equipment to condition existing before initial training use.

### 3.3 SAMPLE AGENDAS

1. The following pages contain a sample agenda for use on this project.
2. Training facilitator or Instructor shall create similar agendas for each system, or piece of equipment not forming a part of a system, for each form of equipment demonstrated to the Owner.

### 3.4 DEMONSTRATION AND INSTRUCTION VIDEOS

1. Engage a qualified commercial videographer to record demonstration and instruction videos:
  1. Record each training module separately.
  2. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
  3. Record each chart containing learning objective and lesson outline at beginning of each training module.
2. Video Format:
  1. Provide high quality video: H.264 format exported as .MP4 file(s).
  2. Method of delivery of video file(s): USB memory stick or Cloud server are acceptable.
3. Recording:
  1. Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and instruction.

2. Display continuous running time.
4. Narration:
  1. Describe scenes on video by audio narration by microphone while or dubbing audio narration off-site after video is recorded. Include description of items being viewed.
  2. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.
5. Transcript:
  1. Provide a typewritten transcript of the narration.
  2. Display images and running time captured from video opposite the corresponding narration segment.

**END OF SECTION**

## **1 General**

### **1.1 RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. Section 01 74 19 – Construction and Demolition Waste Management and Disposal
3. Section 01 81 19 – Construction Indoor Air Quality Requirements
4. LEED Reference Guide for Building Design and Construction (BD+C), version 4/4.1, U.S. Green Building Council

### **1.2 DESCRIPTION OF WORK**

1. Section includes general, administrative, procedural, and product requirements for compliance with the prerequisites and credits of the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) for Building Design and Construction, Version 4.0/4.1 Green Building Rating System.
  1. The owner has established that this Project shall achieve at a minimum LEED Silver.
  2. Several LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
  3. Additional LEED prerequisites and credits required to obtain the selected LEED certification are contingent on the Project design and other aspects of Project that are not part of the Work of the Contract.
  4. Any discrepancies between the LEED Requirements outlined in this Section and those in other Sections require notification of the Architect and the Architect's approval of the resolution.
  5. LEED goals and targeted credits are outlined in the LEED Appraisal appended at the end of this Section.

### **1.3 SUSTAINABLE BUILDING REQUIREMENTS**

1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED v4 Gold. Specific project goals that may impact this area of work including the use of high performance materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan.
2. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

### **1.4 REFERENCE STANDARDS**

1. ANSI/ASHRAE/IESNA 90.1-2010 – Energy Standard for Buildings Except Low-Rise Residential Buildings
2. ANSI/ASHRAE 52.2-2007 – Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
3. ANSI/ASHRAE 62.1-2010 – Ventilation for Acceptable Indoor Air Quality
4. ASHRAE 52.2-2007 – Filtration Minimum Efficiency Reporting Value (MERV)
5. ASTM C1371-04 (R2010) – Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

6. ASTM C1549-04 – Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
7. ASTM D1003-11 – Haze and Luminous Transmittance of Transparent Plastics
8. ASTM E408-13 – Methods for Total Normal Emittances of Surfaces Using Inspection-Meter Techniques
9. ASTM E903-12 – Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
10. ASTM E1918-06 – Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field
11. ASTM E1980-11 – Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
12. ATSM/BIFMA Standard Method M7.1-2011, Standard Test Method for Determining Emissions from Office Furniture Systems, Components and Seating – Furniture evaluation standard for VOC emissions
13. ATSM/BIFMA e3-2011 Furniture Sustainability Standard Section 7.6.1 and 7.6.2 – VOC emission limits for office furniture, components and seating
14. California Air Resources Board (CARB) Airborne Toxic Measure to Reduce Formaldehyde Emissions from Composite Wood Products Regulation
15. CARB Suggested Control Measure for Architectural Coatings, 2007
16. California Title 24-2013, Part 6 – Building Energy Efficiency Standards
17. California Dept. of Public Health Standard Method v1.2-2017, Standard Method for The Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers
18. CRI – Carpet and Rug Institute Green Label and Green Label Plus Testing Program
19. EPA ENERGY STAR – Qualified Products
20. EPA Construction General Permit (CGP): 2012
21. EPA Clean Air Act, Title VI, Section 608, Compliance with the Section 608 Refrigerant Recycling Rule
22. EPA – Energy Policy Act (EPAAct) of 1992 (and as amended), Fixture Flow Requirements
23. EPA – Energy Policy Act (EPAAct) of 2005, Fixture Flow Requirements
24. EPA – Water Sense Label
25. EPA 832-R-92-005 – Storm Water Management for Construction Activities, Chapter 3
26. EPA PB90200288 – Compendium of Methods for the Determination of Air Pollutants in Indoor Air
27. FSC – Forest Stewardship Council's Principles and Criteria
28. Greenguard Certification Program – Greenguard Environmental Institute
29. ISO 14021-1999 – Environmental Labels and Declarations, Self-Declared Environmental Claims (Type II Environmental Labeling)
30. South Coast Air Quality Management District (SCAQMD) Rule #1113 – VOC Limits for Architectural Coatings, effective June 3, 2011
31. SCAQMD Amendment to South Coast Rule #1168 – VOC Limits for Adhesives, Sealant and Sealant Primers, effective July 1, 2005 with a rule amendment date of Jan. 7, 2005
32. USGBC – LEED Version 4 BD&C Reference Guide

## 1.5 DEFINITIONS

1. Chain-of-Custody: A tracking procedure to document the status of a product from the point of harvest or extraction to the ultimate end use.
2. Chain-of-custody certification: Awarded to companies that produce, sell, promote, or trade forest products after audits verify proper accounting of material flows and proper use of the Forest Stewardship Council name and logo. The COC certificate number is listed on invoices for non-labeled products to document that an entity has followed FSC guidelines for product accounting.
3. Chlorofluorocarbons (CFCs): Hydrocarbons that deplete the stratospheric ozone layer.
4. Composite wood: Consists of wood or plant particles or fibers bonded by a synthetic resin or binder. Examples include particleboard, medium-density fiberboard (MDF), plywood, oriented-strand board (OSB), wheatboard, and strawboard.
5. Composite Wood Evaluation: Composite wood, as defined by the "California Air Resources Board, Airborne Toxic Measure to Reduce Formaldehyde Emissions from Composite Wood Products" Regulation, which has been documented to have low formaldehyde emissions that meet the California Air Resources Board ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde (NAF) resins.
6. Declare Product: Products with a Declare transparency label that indicates all ingredients have been evaluated and disclosed down to 1,000 ppm as administered by the International Living Future Institute (<http://living-future.org>).
7. Environmental Product Declaration (EPD):
  1. Product-specific declaration: Products with a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that have at least a cradle to gate scope are valued as one quarter (1/4) of a product for the purposes of credit achievement calculation.
  2. Environmental Product Declarations which conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
    1. Industry-wide (generic) EPD -- Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator are valued as one half (1/2) of a product for purposes of credit achievement calculation.
    2. Product-specific Type III EPD -- Products with third-party certification (Type III), including external verification in which the manufacturer is explicitly recognized as the participant by the program operator are valued as one whole product for purposes of credit achievement calculation.
8. Extended Producer Responsibility (EPR): Program implemented by a product manufacturer to accept its own and sometimes other manufacturers' products as postconsumer waste at the end of the products' useful life. Alternatively known as a manufacturer's take-back program.
9. Forest Stewardship Council (FSC) is an independent, non-governmental, not for profit organization established to promote the responsible management of the world's forests. FSC provides certifications to award forest managers who adopt environmentally and socially responsible forest management practices and to companies that manufacture and sell products that directly support responsible forest management.
10. General Emissions Evaluation: Building product testing in accordance with California Department of Public Health (CDPH) Standard Method v1.2–2017, using the applicable exposure scenario. The default scenario is the private office scenario. The manufacturer's or third-party certification must state the exposure scenario used to determine compliance. Claims of compliance for wet-applied products must state the amount applied in mass per surface area. Manufacturers' claims of compliance with the above requirements must also state the range of total VOCs after 14 days (336 hours), measured as specified in the CDPH Standard Method v1.2: 0.5 mg/m<sup>3</sup> or less; between 0.5 and 5.0 mg/m<sup>3</sup>; or 5.0 mg/m<sup>3</sup> or more.



11. Health Product Declaration (HPD): Products with a published, complete HPD with full disclosure of known hazards and residuals disclosure at no less stringent than 1,000 parts per millions (ppm), in compliance with the Health Product Declaration Open Standard as maintained by the Health Product Declaration Collaborative ([www.hpd-collaborative.org](http://www.hpd-collaborative.org)).
12. Hydrochlorofluorocarbons (HCFCs): Refrigerants used in building equipment that deplete the stratospheric ozone layer, but to a lesser extent than CFCs.
13. Inherently Non-emitting Materials: Naturally occurring materials and products made from inorganic materials that emit either very low or no VOCs. Products that are inherently non-emitting sources of VOCs (stone, ceramic, powder-coated metals, plated or anodized metal, glass, concrete, clay brick, and unfinished or untreated solid wood flooring) are considered fully compliant with the Low-Emitting Materials credit without any VOC emissions testing, if they do not include integral organic based surface coatings, binders, or sealants.
14. Life Cycle Assessment: An evaluation of the environmental effects of a product from cradle (resource extraction) to grave (product disposal), as defined by ISO 14040–2006 and ISO 14044–2006.
15. Material Cost: For the purposes of LEED calculations and tracking, the dollar value of a product furnished for the project including the cost of materials, shop labor, contractor markups, taxes, fees, delivery costs, and all expenses incurred by the contractor to bring the product to the project site. Material cost excludes any cost for site labor and site equipment required for installation on the project site.
16. Point of Harvest/Extraction/Recovery: Location where raw material is gathered for use in production.
17. Point of Manufacturing (Final Assembly): Location where individual components are assembled into a product that is furnished and installed on site.
18. Point of Purchase: Location of the purchase transaction for a product. For online or other transactions that do not occur in person, the point of purchase is considered the location of product distribution.
19. Pre-Consumer Recycled Content: Defined as material diverted from the waste stream during the manufacturing process. Examples in this category include planer shavings, plytrim, sawdust, chips, bagasse, sunflower seed hulls, walnut shells, culls, trimmed materials, print overruns, over-issue publications, and obsolete inventories. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it. (Previously referred to as Post-industrial Content.)
20. Post-Consumer Waste: Waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of materials from the distribution chain. Examples of this category include construction and demolition debris, materials collected through curbside and drop-off recycling programs, broken pallets, discarded products (e.g., furniture, cabinetry and decking) and urban maintenance waste (e.g., leaves, grass clippings, tree trimmings, etc.).
21. Solar Reflectance Index (SRI): A measure of a material's ability to reject solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.9) is equal to 0, and a standard white (reflectance 0.80, emittance 0.90) is equal to 100.
22. Vendor: A Vendor of certified wood is the organization that sells/supplies wood products to contractors or subcontractors. A vendor must have a FSC Chain of Custody (CoC) certificate if it is selling FSC-certified products for which its packaging or form will be modified and/or products that are not individually labeled; this includes most lumber.
23. Volatile Organic Compounds (VOCs): Carbon compounds that participate in atmospheric photochemical reactions (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonates, and ammonium carbonate). The compounds vaporize (become a gas) at normal room temperatures.

## 1.6 ADMINISTRATIVE REQUIREMENTS

1. Respond to questions and requests from Architect and Sustainability/LEED Consultant regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its final determination on the project's LEED certification application. Document responses as informational submittals.

## 1.7 SUBMITTALS

1. General: Submit additional LEED submittals required by other Specification Sections.
2. LEED Product Submittals:
  1. Projects seeking LEED certification must track and record product, material, and cost information for LEED credit documentation. The contractor shall complete and submit the following forms included with product submittals:
  2. Low-Emitting Materials Reporting Form: for all permanently installed products and materials related to the work of any Section installed on the interior of the building (i.e. inside the weatherproofing system) and falling within one of the product categories listed below. The Contractor shall submit:
    1. Completed Low-Emitting Materials Reporting Form. A sample Form for this project has been included in the Appendix of this Section.
    2. For each building product and material listed on the Form, provide information and support documentation for the product as defined in this Section to support all environmental claims listed in the Form. Submittal requirements for the support documentation can be found in the "LEED Credit-Specific Submittal" part of this Section.
    3. Applicable product categories: flooring; composite wood; ceilings, walls, and thermal or acoustic insulation; field-applied adhesives, sealants, paints, and coatings; and furniture products.
  3. BPDO Materials Reporting Form: for all permanently installed products and materials specified in CSI MasterFormat 2012 Edition Divisions 03-12, 31.60.00, 32.10.00, 32.30.00, and 32.90.00. The Contractor shall submit:
    1. Completed BPDO Materials Reporting Form. A sample Form for this project has been included in the Appendix of this Section.
    2. For each building product and material listed on the Form, provide information and supporting documentation for the product as defined in this Section to support all environmental claims listed on the Form. Submittal requirements for the support documentation can be found in the "LEED Credit-Specific Submittal" part of this Section.
3. LEED Credit-Specific Submittals
  1. General
    1. For detailed explanation of credit requirements, refer to LEED v4/4.1 BD+C Reference Guide.
    2. For all MR Credits Building Product Disclosure and Optimization (BPDO) listed below:
      1. Submittals apply to permanently installed products and materials specified in CSI MasterFormat 2012 Edition Divisions 3-12, 31.60.00, 32.10.00, 32.30.00, and 32.90.00.
      2. For all Credit Options 2 outlined below, submit the following for any regionally sourced products that have raw materials extracted and are manufactured and purchased/distributed within 100 mile radius of the Project site: Cut sheet or a written affidavit from the manufacturer indicating,
        1. Location (city, state/province) for points of raw material extraction, product manufacturing (final assembly), and product purchase/distribution.

2. Breakdown of product component materials that are extracted, manufactured, and purchased within 100 miles of the project site and the material percentage of each component by weight.
    3. Distance in miles from the Points of raw material extraction, product manufacturing, and product purchase/distribution to the Project site location, measured as the most direct route between points.
  3. For EQ Credit - Low-Emitting Materials, submittals apply to permanently installed products and materials related to the work of any Section on the interior of the building (i.e. inside the weatherproofing systems) and falling within one of the applicable product categories.
    1. Applicable product categories are listed under "LEED Product Submittals" under the Submittals part of this Section.
    2. Note that LEED v4 publishes a list of approved third-party product certifications and labels, available for download at <http://www.usgbc.org/resources/low-emitting-materials-third-party-certification-table>.
  4. For further explanation of credit requirements, refer to LEED v4 BD+C Reference Guide.
2. MR Credit - BPDO – Environmental Product Declarations (EPD): submit the following documentation.
  1. Credit Option 1 (EPD), either:
    1. Manufacturer's product specific declarations, publicly available, conforming with ISO 14044, and having cradle to gate scope.
    2. Environmental Product Declarations (product-specific or industry-wide). Third party verified Type III EPD conforming with ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and having cradle to gate scope.
  2. Credit Option 2 (Multi-Attribute Optimization): manufacturer's third-party certified life cycle assessments (LCA), demonstrating the required environmental impact reductions compared to industry average.
3. MR Credit - BPDO – Sourcing of Raw Materials: submit the following documentation.
  1. Credit Option 1 (Raw Material Source & Extraction Reporting), submit either:
    1. Manufacturer's third-party verified corporate sustainability reports (CSR) addressing the raw materials supply chain and conforming with one of the following acceptable frameworks:
      1. Global Reporting Initiative (GRI) Sustainability Report
      2. Organization for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises
      3. U.N. Global Compact: Communication of Progress
      4. ISO 26000: 2010 Guidance on Social Responsibility
    2. Manufacturer's self-declared reports addressing the raw materials supply chain.
  2. Credit Option 2 (Leadership Extraction Practices): submit the following as applicable.
    1. Products purchased from a manufacturer (producer) that participates in an Extended Producer Responsibility (i.e., take-back) program: submit company brochure or similar describing the program, including contact information and verification that the product is included in the program.
    2. Products containing Bio-based Materials: submit documentation from the raw-material manufacturer stating conformance to the Sustainable Agricultural Network's Sustainable Agriculture (SANSA) Standard in the form of a signed letter on company letterhead and testing per ASTM Test Method D6866.

3. Products containing Recycled Content: submit product cut sheet or a written affidavit on company letterhead (email is not acceptable) from the manufacturer indicating the percentages, by material weight, of post-consumer and pre-consumer recycled content.
4. Products that are salvaged, refurbished, or reused: submit statement of source of materials, including statement of costs. The cost of reclaimed materials is either the actual cost paid or the replacement value, whichever is higher. Replacement cost is determined by pricing comparable materials in the local market, excluding labor and shipping, and shall reflect any price discounts if applicable.
5. Permanently installed non-recycled wood and wood based material, submit the following:
  1. Forest Stewardship Council's Chain of Custody (CoC) Certification Number for each installed certified wood product, declaring conformance with FSC Guidelines for certified wood. COC numbers shall be obtained from the manufacturer and must be itemized on a line-item basis. When applicable, a COC number is required by the source forest, transportation entity, supplier/manufacturer, and vendors of the material.
  2. Vendor invoices, including all FSC-certified and non FSC-certified wood products purchased. Vendors are defined as those companies that sell products to the project contractor or subcontractors for installation on the Project site. Invoices must include:
    3. Itemization of each wood product identified as such on a line item basis
    4. FSC products identified as such on a line-item basis and must be identified as "FSC Pure, FSC Mixed Credit", or "FSC Mixed [NN] %"
    5. The dollar value of each line item
      1. iv. The vendor's chain-of-custody (CoC) number must be shown on any invoice that includes FSC products.
      2. If it is impractical for a vendor to invoice wood products on a line-item basis because the invoice would be excessive in length, the invoice should indicate the aggregate value of wood products sold by the vendor.
4. MR Credit - BPDO – Material Ingredients: submit the following documentation.
  1. Credit Option 1 (Material Ingredient Reporting), submit at least one of the following for the end use product:
    1. Manufacturer's publicly available ingredient inventory of all ingredients identified by name and Chemical Abstract Service Registration Number (CASRN) to at least 0.1% (1,000 ppm).
    2. Health Product Declaration (HPD) with full disclosure of known hazards to at least 0.1% (1,000 ppm).
    3. Cradle to Cradle certificate (minimum v2 Basic or v3 Bronze level).
    4. Declare Label indicating that all ingredients have been evaluated and disclosed to at least 0.1% (1,000 ppm).
    5. UL Product Lens certification.
  2. Credit Option 2 (Material Ingredient Optimization), submit at least one of the following for the end use product:
    1. GreenScreen v1.2 Benchmark, indicating full inventory of chemical ingredients to 100 ppm with no Benchmark 1 hazards. Identify whether ingredients have been assessed with the GreenScreen List Translator or full GreenScreen Assessment.
    2. Cradle to Cradle certificate (minimum v2 Gold or v3 Silver level).
    3. REACH compliance for materials that do not contain substances that meet REACH criteria for substances of very high concern. Identify any ingredients listed on REACH Authorization or Candidate lists.

5. EQ Credit - Low-Emitting Materials: submit the following documentation, as applicable for products installed on site inside the building weatherproofing layer.
  1. Interior composite wood and agrifiber products, including core materials: submit documentation of compliance with or exemption from the LEED v4 Composite Wood Evaluation, such as a cut sheet or written affidavit from the manufacturer stating that they meet the applicable CARB ATCM requirements for ultra-low-emitting formaldehyde (ULEF) or no added formaldehyde (NAF) resins.
  2. Interior flooring products, including but not limited to carpet, resilient flooring, engineered wood, and mineral-based tile: submit documentation of compliance with LEED v4 General Emissions Evaluation (VOC emissions testing or approved third-party certification) for each installed product or system.
  3. Interior wet-applied, field installed interior products listed below: submit documentation of compliance with both VOC content limits and LEED v4 General Emissions Evaluation (VOC emissions testing or approved third-party certification).
    1. Adhesives/Sealants/Paints/Coatings: submit Material Data Safety Sheet (MSDS) or product data sheets highlighting VOC content measured in grams per liter (g/L) less water and exempt solvents, and LEED v4 General Emissions Evaluation documentation (VOC emissions testing or approved third-party certification).
  4. Interior ceiling assemblies, wall assemblies, and insulation (thermal or acoustic): submit documentation of compliance with LEED v4 General Emissions Evaluation (VOC emissions testing or approved third-party certification).
  5. Interior furniture and furnishings: submit documentation of compliance with LEED v4 Furniture Evaluation, including testing per ANSI/BIFMA Standard Method M7.1-2011 and compliance with ANSI/BIFMA e3-2011 Furniture Sustainability Standard, Sections 7.6.1 and 7.6.2.
  6. Inherently non-emitting materials: In lieu of above, submit manufacturer's certification stating that the product qualifies as inherently non-emitting, as defined in this Section.
6. WE Prerequisite and Credit - Indoor Water Use Reduction: for plumbing fixtures, submit cut sheets with water consumption flow/flush rates highlighted.
7. EQ Credit - Construction Indoor Air Quality Management Plan: for submittal requirements, refer to Section 01 81 19 - Construction Indoor Air Quality Requirements.
8. MR Prerequisite and Credit - Construction and Demolition Waste Management: for submittal requirements, refer to Section 01 74 19 - Construction and Demolition Waste Management.
4. LEED Submission Documentation:
  1. At or before substantial completion, the Contractor shall prepare supporting documentation for each LEED construction prerequisite and credit to be attempted, which have been assigned to the Contractor by the Owner or Architect.
    1. Sustainability/LEED Consultant shall prepare and distribute a LEED v4 Documentation List to the Contractor. The LEED v4 Documentation List outlines the deliverables required to adequately record that the project has met the intent of each credit.
    2. Contractor shall register and log-in to LEED Online (<http://www.leedonline.com>).
    3. Contractor shall complete LEED Online credit forms and upload associated required backup documentation for all the credits assigned in the LEED v4 Documentation Matrix. The LEED Online credit forms shall contain:
      1. All proper data fields completed declaring that the project has met the intent of the credit, including narrative(s) when applicable.
      2. Electronic signature of Contractor and date signed, where required.
    4. The Contractor shall notify sustainability/LEED Consultant of completion of LEED Online documentation and availability for review.

## 2 Products

### 2.1 UNAUTHORIZED PRODUCTS

1. Materials and products required for Work of this Section shall not contain asbestos, polychlorinated biphenyls (PCBs) or other hazardous materials identified by the Owner.

### 2.2 MATERIALS, GENERAL

1. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated.
2. LEED Performance Criteria: Products and Materials shall meet the following project-wide criteria as well as applicable product-specific criteria in Part 2 of this Section.
  1. MR Credit - BPDO - EPD, Option 1 (EPD):
    1. Install at least twenty (20) different permanently installed products (or an equivalent quantity of partially valued products) sourced from at least five (5) different manufacturers that meet criteria described in the LEED v4 BD+C Reference Guide. Examples of partially-valued products include non-product specific, industry-wide EPDs, which are valued as one-half of a product for the purposes of this LEED credit.
  2. MR Credit - BPDO - Sourcing of Raw Materials, Option 2 (Leadership Extraction Practices):
    1. Install products that meet at least one (1) of the LEED v4 responsible extraction criteria described in the LEED v4 Reference Guide and in aggregate comprise at least 25 percent, by cost, of the total value of permanently installed building products in the Project.
  3. MR Credit - BPDO - Material Ingredients, Option 1 (Material Ingredient Reporting):
    1. Install at least twenty (20) different permanently installed products sourced from at least five (5) different manufacturers that meet criteria described in the LEED v4 BD+C Reference Guide.
  4. EQ Credit - Low-Emitting Materials VOC-Containing Products: Install interior products that meet overall Project compliance levels, as listed below and described in the LEED v4 Reference Guide.
    1. Field-applied interior adhesives, sealants, paints, and architectural coatings:
      1. 100 percent compliance for VOC content criteria
      2. Minimum 90 percent compliance (by volume) for VOC emissions criteria (General Emissions Evaluation).
    2. Flooring products: 100 percent compliance (General Emissions Evaluation).
    3. Composite wood products: 100 percent compliance (Composite Wood Evaluation).
    4. Ceiling assemblies, wall assemblies, and insulation (acoustic or thermal insulation): 100 percent compliance (General Emissions Evaluation).
    5. Furniture included in Project scope of work: minimum 90 percent compliance, by cost (Furniture Evaluation).

### 2.3 ADHESIVES

1. Wet-applied adhesives used in the building interior (i.e. inside of the exterior moisture barrier) must comply with all of the following criteria:
  1. General Emissions Evaluation, as defined in this Section.
  2. Maximum VOC content limits and chemical content requirements established by SCAQMD Rule #1168, July 1, 2005 Amendment, including, but not limited to, the following:
  3. Architectural Adhesives Applications:

1. Indoor Carpet Adhesives: 50 g/L.
2. Carpet pad adhesives: 50 g/L.
3. Outdoor Carpet Adhesives: 150 g/L.
4. Wood Flooring Adhesives: 100 g/L.
5. Rubber Floor Adhesives: 60 g/L.
6. Subfloor Adhesives: 50 g/L.
7. Ceramic tile installation: 65 g/L.
8. VCT and asphalt tile installation: 50 g/L.
9. Dry Wall and Panel Adhesives: 50 g/L.
10. Cove base installation: 50 g/L.
11. Multipurpose Construction Adhesives: 70 g/L.
12. Structural Glazing Adhesives: 100 g/L.
4. Substrates:
  1. Metal to metal: 30 g/L.
  2. Plastic foams: 50 g/L.
  3. Porous material except wood: 50 g/L.
  4. Wood: 30 g/L.
  5. Fiberglass: 80 g/L.
5. Specialty Applications:
  1. PVC welding: 510 g/L.
  2. CPVC welding: 490 g/L.
  3. ABS welding: 325 g/L.
  4. Plastic cement welding: 250 g/L.
  5. Adhesive primer for plastic: 550 g/L.
  6. Contact Adhesive: 80 g/L.
  7. Special Purpose Contact Adhesives: 250 g/L.
  8. Structural Wood Member Adhesive: 140 g/L.
  9. Sheet Applied Rubber Lining Operations: 850 g/L.
  10. Top and Trim Adhesive: 250 g/L.
6. Methylene chloride and perchloroethylene may not be intentionally added ingredients.

## 2.4 SEALANTS

1. Wet-applied sealants used in the building interior (i.e. inside of the exterior moisture barrier) must comply with all of the following criteria:
  1. General Emissions Evaluation, as defined in this Section.
  2. Maximum VOC content limits and chemical content requirements established by SCAQMD Rule #1168, January 1, 2023 effective, including, but not limited to, the following:
    1. Clear, Paintable, and Immediately Water Resistant Sealant: 250 g/L
    2. Foam Insulation: 5%
    3. Grout: 65 g/L
    4. Architectural Sealants: 50 g/L
3. Methylene chloride and perchloroethylene may not be intentionally added ingredients.

## 2.5 PAINTS

1. Wet-applied paints used in the building interior (i.e. inside of the exterior moisture barrier) must comply with all of the following criteria:
  1. General Emissions Evaluation, as defined in this Section.
  2. Maximum VOC content limits established by the more stringent of SCAQMD Rule #1113, January 1, 2019 effective or California Air Resources Board (CARB) 2007, Suggested Control Measure for Architectural Coatings, including, but not limited to, the following:

1. Flat paint and primer: 50 g/L
  2. Non-flat paint and primer: 50 g/L
  3. Concrete curing compounds: 100g/L
  4. Rust-preventative paint and primer: 100 g/L
3. Methylene chloride and perchloroethylene may not be intentionally added ingredients.

## 2.6 ARCHITECTURAL COATINGS

1. Wet-applied architectural coatings used in the building interior (i.e. inside of the exterior moisture barrier) must comply with all of the following criteria:
  1. General Emissions Evaluation, as defined in this Section.
  2. Maximum VOC limits established by the more stringent of SCAQMD Rule #1113 VOC Limits for Architectural Coatings, January 1, 2019 effective or California Air Resources Board (CARB) 2007, Suggested Control Measure for Architectural Coatings, including, but not limited to, the following:
    1. Bond Breakers: 350 g/L
    2. Clear Wood Finishes
      1. Varnish: 275 g/L
      2. Sanding Sealers: 275 g/L
      3. Lacquer: 275 g/L
  3. Concrete-curing compounds (non-roadway): 100 g/L
  4. Concrete surface retarder: 50 g/L
  5. Dry-fog coatings: 50g/L
  6. Fire proofing coatings: 150 g/L
  7. Flat coatings: 50 g/L
  8. Floor coatings: 50 g/L
  9. Form release compound: 100 g/L
  10. Graphic arts (signs) coatings: 200 g/L
  11. Industrial Maintenance (IM) coatings: 100 g/L
  12. IM coatings (High temperature): 420 g/L
  13. IM primers (Zinc-rich): 100 g/L
  14. Japan/faux finishing coatings: 350 g/L
  15. Magnesite cement coatings: 450 g/L
  16. Mastic coatings: 100 g/L
  17. Metallic pigmented coatings: 150 g/L
  18. Multi-color coatings: 250 g/L
  19. Non-flat coatings: 50 g/L
  20. Pre-treatment wash primers: 420 g/L
  21. Primers, sealers, undercoaters: 100 g/L
  22. Recycled coatings: 250 g/L
  23. Rust preventative coatings: 100 g/L
  24. Shellac-Clear: 730 g/L
  25. Shellac-Pigmented: 550 g/L
  26. Stains: 100 g/L
  27. Traffic coatings: 100 g/L
  28. Waterproofing sealers: 100 g/L
  29. Waterproofing concrete/masonry sealers: 100 g/L
  30. Wood preservatives: 350 g/L
3. Methylene chloride and perchloroethylene may not be intentionally added ingredients.

## 2.7 FLOORING SYSTEMS

1. Carpet systems or assemblies must meet or exceed the General Emissions Evaluations as described in the submittals part of this Section.



2. Carpet adhesives must meet product requirements for Adhesives, as defined in this Section.
3. Hard surface flooring must meet or exceed General Emissions Evaluations as described in the Submittals part of this Section.
  1. This requirement does not apply to mineral-based finish flooring products such as tile, masonry, terrazzo, and cut stone without integral organic-based coatings and sealants and unfinished/untreated solid wood flooring.
  2. Associated site-applied adhesives, grouts, finishes and sealers must meet applicable requirements for Adhesives, Sealants, or Coatings, as defined in this Section.
4. Site-applied concrete, wood, bamboo and cork floor finishes such as sealer, stain and finish must meet applicable requirements for Adhesives, Sealants, or Coatings, as defined in this Section.
5. Tile setting adhesives and grout must meet applicable requirements for Adhesives, Sealants, or Coatings, as defined in this Section.

## **2.8 CEILING SYSTEMS**

1. Ceiling systems such as overhead, structural elements (exposed, finished or unfinished), direct-applied, suspended, glazed skylights must meet General Emissions Evaluation as described in the Submittals part of this Section.

## **2.9 WALL SYSTEMS**

1. Wall systems such as cabinetry, interior or exterior glazing, doors, interior columns, partial-height and full-height vertical structures (exposed, finished or unfinished) must meet General Emissions Evaluation as described in the Submittals part of this Section.

## **2.10 ACOUSTIC AND THERMAL INSULATION**

1. Insulation installed inside of the weatherproofing barrier, such as thermal and acoustical boards, batts, rolls, blankets, loose fill and spray foam insulation must meet General Emissions Evaluation as described in the Submittals part of this Section.

## **2.11 WOOD AND WOOD PRODUCTS**

1. New, non-recycled wood and wood based materials shall be certified in accordance with Forest Stewardship Council (FSC) Guidelines. This includes wood permanently installed in the project but is not limited to structural framing and dimensional lumber, blocking, flooring, finished woodwork, doors, millwork, casework, and elevator panels.
2. No partial claims shall be made for products that contain FSC certified wood but are not sold with a FSC claim. A product that contains a mix of FSC-certified components with non-certified components is not considered a FSC Mixed product in an assembly and is not eligible to receive credit for the certified portion. The product shall only contribute to the MR LEED credit if the product complies with FSC Chain-of-Custody rules for Mixed products and the invoice carries a valid FSC claim and chain of custody number.
3. Contractors and subcontractors that temporarily possess FSC-certified material prior to installation shall not mix FSC-certified material with non-FSC-certified material.
4. Chain of Custody (CoC) Requirements:
  1. Transportation entities shall require a CoC when the transport to the next entity involves a change of ownership of the material or product. Shippers or transport companies handling goods owned by FSC CoC certified companies are exempt.
  2. Each wood products supplier and/or manufacturer that invoices FSC-certified wood products to a vendor must be certified by an FSC-accredited certifier.
  3. Each wood products vendor that invoices FSC-certified wood products to product contractors and subcontractors must be certified by an FSC-accredited certifier.

4. Parties that manufacture products off-site and then install them on-site must be FSC CoC certified for the products to contribute to the LEED credit. This includes, but is not limited to, cabinetmakers and architectural millworkers.
5. Parties that do not manufacture, but install an FSC-certified product on the project site, do not require FSC Chain of Custody certification as long as they do not modify the product packaging or form except for the purposes of installation. This includes, but is not limited to, contractors, subcontractors, and furniture installers.
6. If a manufacturer places its FSC CoC label on product packaging used for individual sale (generally applying to fabricated products), than subsequent entities in the supply chain are not required to have CoC certification unless the product's packaging or form is changed before it reaches the end consumer.
7. For products that are not individually packaged for sale to be sold as FSC certified, the vendor to the consumer is required to have CoC certification. Contractors and subcontractors are considered the end consumers and may demonstrate with copies of invoices (if requested) the quantity purchased for the job and their suppliers' CoC numbers.

## **2.12 COMPOSITE WOOD AND AGRIFIBER PRODUCTS**

1. Composite wood and agrifiber board products shall comply with the Composite Wood Evaluation by meeting Phase 2 CARB formaldehyde emission limits and CARB ATCM requirements for ultra-low-emitting formaldehyde (ULEF) or no added formaldehyde (NAF) resins.

## **2.13 PLUMBING FIXTURES**

1. Plumbing fixtures must not exceed the LEED flow maximum water consumption requirements, as described by the EPA Energy Policy Act (EPA) of 1992 and if eligible, all newly installed toilets, urinals, private lavatory faucets, and showerheads must be WaterSense labeled:
  1. Appliances
    1. Residential dishwashers (standard and compact): Energy Star or performance equivalent.
2. Plumbing fixtures scheduled in the Construction Documents have been specified to meet a calculated aggregate reduction in potable water consumption by a minimum of twenty percent (20%) compared to the EPA 1992 baseline. Substitutions shall not be allowed if such changes compromise the required reductions.

# **3 Execution**

## **3.1 METERING**

1. EA Prerequisite - Building-Level Energy Metering: Install new building-level energy meters to provide data representing total building energy consumption (electricity, natural gas, chilled water, steam, fuel oil, propane, biomass, etc.)
2. WE Prerequisite - Building-Level Water Metering: Install new building-level water meters to provide data representing the total potable water consumption for the building and associated grounds.
3. Coordinate the installation and verification of equipment with the Owner.

## **3.2 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT**

1. MR Prerequisite and Credit - Construction and Demolition Waste Management Planning: Comply with CWM Plan

## **3.3 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT**

1. EQ Credit - Construction IAQ Management Plan: Comply with Section 01 81 19 – Construction Indoor Air Quality Requirements.

2. EQ Credit - Indoor Air Quality Assessment: Comply with the following credit option in accordance with Section 01 81 19 - Construction Indoor Air Quality Requirements:
  1. Option 2: Air Quality Testing

### 3.4 APPENDICES

1. APPENDIX A-018113 – LOW-EMITTING MATERIALS REPORTING FORM
2. APPENDIX B-018113 – BPDO MATERIALS REPORTING FORM

**END OF SECTION**

## **1 General**

### **1.1 RELATED DOCUMENTS**

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. Section 01 81 13 - Sustainable Design Requirements.
3. All technical Sections of the Specifications related to interior construction and finish materials, MEPFP systems, and items affecting indoor air quality.
4. LEED Reference Guide for Building Design and Construction (BD+C), version 4, U.S. Green Building Council.

### **1.2 DESCRIPTION OF WORK**

1. This Section includes requirements for the development of a Construction Indoor Air Quality Management Plan (herein referred to as the Plan). The Plan shall be developed by the Contractor and approved by the Owner and Architect / Consultant. The Plan shall be implemented throughout the duration of the Project construction under the direction of the Contractor's IAQ Representative and shall be documented per the Submittal Requirements in Part 1 of this Section. The Plan is part of the Project LEED Requirements.

### **1.3 CONSTRUCTION IAQ MANAGEMENT GOALS FOR THE PROJECT**

1. The Owner has established that this Project shall minimize the detrimental impacts on Indoor Air Quality (IAQ) resulting from construction activities. Factors that contaminate indoor air, such as dust entering HVAC systems and ductwork, improper storage of materials on-site, and poor housekeeping, shall be minimized.

### **1.4 DEFINITIONS**

1. Volatile Organic Compounds (VOC's): Carbon compounds that participate in atmospheric photochemical reactions (excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonates, and ammonium carbonate). The compounds vaporize (become a gas) at normal room temperatures. These compounds are common in and emitted by many building products, including solvents in paints, coatings, adhesives and sealants, wood preservatives; composite wood binder, and foam insulations. Not all VOC's are harmful, but many of those contained within building products contribute to the formation of smog and may irritate building occupants or construction workers by their smell and/or health impact.
  1. Materials that act as "sinks" for VOC contamination: absorptive materials, typically dry and soft (such as textiles, carpeting, acoustical ceiling tiles and gypsum board) that readily absorb VOC's emitted by "source" materials and release them over a prolonged period of time.
  2. Materials that act as "sources" for VOC contamination: products with high VOC contents that emit VOC's either rapidly during application and curing (typically "wet" products, such as paints, sealants, adhesives, caulks and sealers) or over a prolonged period (typically "dry" products such flooring coverings with plasticizers and engineered wood with formaldehyde).
2. Minimum Efficiency Reporting Value (MERV): Filter rating established by ASHRAE and determined according to ASHRAE Standard 52.2-2007. MERV categories range from 1 (very low efficiency) to 16 (very high efficiency),

### **1.5 REFERENCE STANDARDS**

1. ANSI/SMACNA 008-2008, "IAQ Guidelines for Occupied Buildings Under Construction", Second Edition 2007, Chapter 3, The Sheet Metal and Air Conditioner National Contractors Association (SMACNA), [www.smacna.org](http://www.smacna.org).

2. ANSI/ASHRAE 52.2-2007, "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size", [www.ashrae.org](http://www.ashrae.org).
3. EPA PB90200288 – Compendium of Methods for the Determination of Air Pollutants in Indoor Air, U.S. Environmental Protection Agency (EPA), 1990, available from National Technical Information Service, [www.ntis.gov](http://www.ntis.gov)

#### **1.6 CONSTRUCTION IAQ MANAGEMENT PLAN (DURING CONSTRUCTION) - OVERVIEW**

1. The Contractor shall implement indoor air quality management during construction per the requirements of LEED EQ Credit 3 - Construction Indoor Air Quality Management Plan.
2. The Contractor shall prepare and submit a Construction IAQ Management Plan for the construction and pre-occupancy phases of the Project to the Owner and Architect / Consultant. The Construction IAQ Management Plan shall meet the following criteria:
  1. Construction activities shall be planned to meet or exceed the minimum requirements included in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction", as listed in Part 1 of this Section.
  2. Absorptive or porous materials shall be protected from moisture damage when stored on-site and after installation. Contractor shall not install water damaged materials in the building.
  3. Filtration media shall be installed to protect ductwork and/or HVAC equipment used during the construction process, per the requirements of Part 2 of this Section.
  4. The use of tobacco products shall be prohibited inside the building and within 25 feet of the building entrance during construction.
  5. Only low-emitting and low- or no-VOC products shall be installed in the field on the interior of the Project, per the requirements of Division 01 Section 01 81 13 - Sustainable Design Requirements. Examples of such products include, but are not limited to, adhesives, sealants, paints, coatings, and carpet.
  6. A Sequence of Finish Installation Plan shall be developed, highlighting measures to reduce the absorption of VOCs by materials that act as "sinks".
  7. Upon approval of the Plan by the Owner and Architect / Consultant, it shall be implemented by the Contractor and Subcontractors throughout the duration of the construction process and documented in accordance with the LEED Submittal Requirements of this Section.

#### **1.7 CONSTRUCTION IAQ MANAGEMENT PLAN (DURING CONSTRUCTION) – DETAILED REQUIREMENTS**

1. The SMACNA "IAQ Guidelines for Occupied Buildings Under Construction" (Chapter 3) outline IAQ measures in five categories as listed below. The Construction IAQ Management Plan shall be organized in accordance with the SMACNA format and shall address measures to be implemented by the Contractor and/or Subcontractors in each of the five SMACNA categories (including subsections). All subsections shall be listed in the Plan; items that are not applicable for this project should be listed as such.
  1. HVAC Protection:
    1. Return Side
    2. Central Filtration
    3. Supply Side
    4. Duct Cleaning
  2. Source Control
    1. Product Substitution
    2. Modifying Equipment Operation
    3. Changing Work Practices
    4. Local Exhaust
    5. Air Cleaning
    6. Cover or Seal

3. Pathway Interruption
  1. Depressurize Work Area
  2. Pressurize Occupied Space
  3. Erect Barriers to Contain Construction Areas
  4. Relocate Pollutant Sources
  5. Temporarily Seal the Building
4. Housekeeping
  1. Suppressing dust
  2. Cleaning and excess applications of products containing solvents
  3. Addressing spills, water conditions, and accumulated water
  4. Vacuuming
  5. Protecting porous materials and other building systems from exposure to moisture and contamination
5. Scheduling
  1. Sequencing installation of materials
  2. Installation during unoccupied periods
  3. Avoid building occupancy while construction-related pollutants are still present
2. Protection of Materials from Moisture Damage: Under the Housekeeping section of the Plan, describe measures to prevent installed materials or material stored on-site from moisture. This section should also describe measures to be taken if moisture damage does occur to absorptive materials during the course of construction.
  1. Store materials on elevated platforms or pallets under cover and in a dry location.
  2. If materials are not stored in an enclosed location, cover tops and sides of materials with waterproof sheeting, securely tied.
  3. Phase construction such that absorptive materials are installed only in areas that are weather-tight.
3. Protection of Ductwork: Under the HVAC Protection section of the Plan, describe measures to protect air handling and distribution equipment and air supply and return ducting during construction.
  1. All ductwork arriving on site shall have the ends and openings sealed with plastic sheeting and stored on pallets or dunnage until installed. Plastic seals shall remain in place during ductwork installation and shall be repaired or replaced as necessary to maintain continuous protection throughout the duration of construction.
  2. The Contractor shall cover and protect all exposed air inlets and outlets, openings, grilles, ducts, plenums, etc. to prevent water, moisture, dust and other contaminant intrusion.
  3. All ductwork shall be stored on site above the ground or floor slabs.
  4. Ducting runs shall be protected at the end of each day's work.
  5. The Contractor shall apply protection immediately after ducting.
  6. The Contractor's designated IAQ Representative shall inspect work and monitor subcontractor(s) to ensure compliance.
4. Temporary Filtration: The Contractor shall inspect temporary filtration weekly and replace as required to maintain the proper ventilation rates in the building.
  1. Filtration Media shall meet the requirements as listed in Part 2 of this Section.
5. Replacement of Filtration Media: Under the HVAC Protection section of the Plan, provide a description of the filtration media in all ventilation equipment used during construction. The description shall include replacement criteria for filtration media during construction and confirmation of filtration media replacement for all equipment immediately prior to occupancy.

1. Filtration media shall meet the requirements of Part 2 of this Section. As part of required LEED Submittals outlined in Part 1 of this Section, at the end of construction the Contractor shall provide a confirmation that all filtration media were replaced prior to occupancy.
6. Sequence of Finish Installation for Materials
  1. Absorptive materials should be installed after the installation of materials or finishes which have high short-term emissions of VOC's, formaldehyde, particulates, or other air-borne compounds.
    1. Absorptive materials ("sinks") include, but are not limited to: carpets; acoustical ceiling panels; fabric wall coverings; insulations (exposed to the air stream); upholstered furnishings; and other woven, fibrous or porous materials.
    2. Materials with high short-term emissions ("sources") include, but are not limited to: adhesives, sealants and glazing compounds (specifically those with petrochemical vehicles or carriers); paints, wood preservatives and finishes; control and/or expansion joint fillers; hard finishes requiring adhesive installation; finish processes and products associated with gypsum board installation; and composite or engineered wood products with formaldehyde binders.
  2. The Contractor shall develop a Sequence of Finish Installation Plan and schedule that identifies how the sequencing of finish material installation will occur for the project. The schedule shall be submitted to the Owner and Architect / Consultant in accordance with the Submittal Requirements of this Section.
7. Ventilation during installation of materials and finishes: outside air shall be provided during the installation of materials and finishes, beginning after the building is substantially enclosed. If permanent building HVAC systems are used to supply the ventilation air, filtration media shall be installed per the requirements of Part 2 of this Section.

#### **1.8 CONSTRUCTION IAQ MANAGEMENT PLAN (BEFORE OCCUPANCY)**

1. As directed by the Owner, the Contractor shall implement the following prior to occupancy per the requirements of LEED EQ Credit 4 - Indoor Air Quality Assessment. After construction ends, with all interior finishes and movable furnishings installed, major VOC-related punch list items finished, the building completely cleaned, and prior to occupancy, the Contractor shall assist in coordinating and implementing the following compliance option.
  1. Air Quality Testing: Conduct base line IAQ testing out in accordance with the requirements and standard methods outlined in the LEED Reference Guide for Building Design and Construction (BD+C), version 4. Concentrations of contaminants shall be tested and shall not exceed maximum levels specified in the Reference Guide. For each sampling point where the concentration exceeds the limit, take corrective action and retest for the noncompliant contaminants at the same sampling points. Repeat until all requirements are met.

#### **1.9 LEED SUBMITTAL REQUIREMENTS**

1. The Contractor shall submit the following required records and documents:
  1. Prior to start of construction, submit the following:
    1. A construction schedule outlining the start-up date and expected duration of all Construction IAQ Management Plan control measures.
    2. A copy of the Construction IAQ Management Plan and the Sequence Installation Plan for approval by the Owner and Architect / Consultant, as defined in Part 1 of this Section.

2. Product cut-sheets for all filtration media used during construction and installed immediately prior to occupancy, with MERV values highlighted and meeting the criteria for filtration media in Part 2 of this Section. Cut sheets shall be submitted with the Contractor's 'approved' stamp as confirmation that the products submitted are the same products installed on the project.
2. The contractor shall submit the following during construction:
  1. Schedule Q1 – General Contractor Checklist & Log
    1. The General Contractor shall carry out an inspection of the building to verify compliance with the requirements of this specification section. To document this inspection, the General Contractor shall complete Schedule Q1 on a weekly basis. This schedule must be completed and supported by date-stamped digital photos from building close-in until the building is turned over to the Owner. Submit this schedule and supporting photos to the Consultant on a monthly basis as part of the Monthly LEED Construction.
  2. Schedule Q2 – Mechanical Contractor Checklist & Log:
    1. The Mechanical Contractor shall carry out an inspection of the mechanical aspects of building to verify compliance with the requirements of this specification section. To document this inspection, the Mechanical Contractor shall complete Schedule Q2 on a weekly basis. This schedule must be completed and supported by date-stamped digital photos from building close-in until the building is turned over to the Owner. Submit this schedule and supporting photos to the Consultant on a monthly basis as part of the Monthly LEED Construction Report.
  3. Monthly LEED Construction Report
    1. Within 10 working days after the end of each month, the Contractor shall submit the following items as part of the Monthly LEED Construction Report including the below schedule documents attached to this section:
      1. Schedule Q1 and supporting photos.
      2. Schedule Q2 and supporting photos.
3. At end of construction, submit the following:
  1. Photographs that document the implementation of the Construction IAQ Management Plan throughout the course of the project construction. Submit a minimum of (18) photographs, (6) photographs taken on at least (3) different occasions during construction, each labeled with the SMACNA control measure illustrated. Examples include photographs of ductwork sealing and protection, temporary ventilation measures, and conditions of on-site materials storage to prevent moisture damage. Photographs shall include integral date stamping and shall be submitted with brief descriptions or be referenced to project meeting minutes or similar project documents.
  2. Construction IAQ Management Summary Report.
  3. Required documentation for LEED v4 EQ credit 3 - Construction Indoor Air Quality Management Plan and EQ credit 4 - Indoor Air Quality Assessment, including completed credit forms and supporting documentation.

## **2 Products**

### **2.1 FILTRATION MEDIA**

1. Construction filters: If permanently installed air handlers are used during construction, filtration media must be installed at each return grill and air handling unit, having a Minimum Efficiency Reporting Value (MERV) of at least 8 as determined by ASHRAE Standard 52.2-2007. All construction filtration media shall be replaced immediately prior to occupancy.



2. Final filters: Replace all filtration media immediately prior to occupancy. For all ventilation systems that supply outside air, install filters having a Minimum Efficiency Reporting Value (MERV) of 13 or better as determined by ASHRAE Standard 52.2-2007.

## **2.2 BUILDING MATERIALS**

1. Low-emitting products specified in technical Sections of the Project Manual. VOC content shall comply with requirements specified in Division 01 Section 018113 - Sustainable Design Requirements.
2. Dust Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches, commencing with installation of finishes inside the Project.

## **2.3 CLEANING SUPPLIES**

1. Use low toxicity cleaning supplies for surfaces, equipment and workers personal use, during periodic and final cleaning. Comply with requirements for closeout and final cleaning specified in Division 01.

# **3 Execution**

## **3.1 IMPLEMENTATION AND COORDINATION**

1. The Contractor shall be responsible for implementation of the Construction IAQ Management Plan and for the coordination of the Plan with all affected trades per the requirements of Part 1 of this Section.
  1. The Contractor shall designate one individual as the Construction IAQ Representative, who will be responsible for communicating the progress of the Plan with the Owner and Architect / Consultant on a regular basis and for assembling the required LEED documentation.
  2. The Contractor shall include provisions in the Construction IAQ Management Plan for addressing conditions in the field that do not adhere to the Plan, including provisions to implement a stop work order or to rectify non-compliant conditions.
2. The Contractor shall include procedures related to IAQ Management on the agenda during pre-construction meetings and during regularly scheduled meetings on the jobsite. Minutes shall be recorded at all such meetings.
3. Trade subcontractors shall be responsible for the implementation of specific control measures, as specified in the Construction IAQ Management Plan. Subcontractors shall coordinate their responsibilities through the Contractor and their designated Construction IAQ Representative.

## **3.2 ONSITE QUALITY CONTROL**

1. Site Inspections
  1. The Contractor and Mechanical Sub-contractors shall inspect IAQ measures on a weekly basis after building close-in. Inspections must continue until the building is turned over to the Owner.
  2. Record the IAQ measures that are in place, their locations and their conditions at the time of inspection using Schedule Q1 and Q2.
  3. Take date-stamped digital photos of all measures during each inspection.
2. Conforming Work: Where one or more measures have been jeopardized, the contractor shall remediate as required and reinstate the measure immediately. Should any of the measures associated with protecting the HVAC ductwork be rendered ineffective, the ducts shall be cleaned at the Contractor's expense; the requirement to clean the ducts will be at the discretion of the Owner or their designated representative.
3. Special Inspection Coordination: LEED Consultant inspections will take place intermittently throughout construction and provide feedback to the Contractor as to the status of the IAQ management.

### 3.3 IAQ MEASURES AND PROCEDURES

#### 1. Source Control

1. Smoking is not permitted within 10m of the building at any time. The Contractor shall post "No Smoking" signs throughout the building to enforce this requirement.
2. All toxic chemicals and fuels are to be storage outside of the building.
3. Keep idling trucks away from open portions of the building, outdoor air inlets, and open doorways.
4. All equipment refueling is to be done outside of the building.
5. After close-in, gas powered equipment is not permitted to be used in the building without prior approval from the LEED Consultant. Preference will be given to electric or propane powered equipment.
6. All adhesives, sealants, paints and coatings applied onsite and used within the weatherproofing system must satisfy the requirements of specification Section 01 81 13.
7. Where practicable, assemble products and assemblies that require the use of adhesives, sealants, paints and coatings offsite (e.g. millwork).
8. Where practicable, allow new materials, products and assemblies to off gas prior offsite or in a dedicated and isolated area within the building prior to installation (e.g. furniture).

#### 2. Scheduling

1. Weatherproof the building from the exterior environment as quickly as possible. Schedule installation of moisture-control materials, including but not limited to air barriers, flashing, exterior sealants and roofing, at the earliest possible time.
2. Schedule construction operations involving wet and/or odorous materials prior to installation of dry and/or absorbent materials. Install interior absorptive materials only after the building envelope is sealed and weatherproofed.
3. Once installed, protect absorbent materials including, but not limited to, porous insulations, paper-faced gypsum board, ceiling tile, and carpet from dust, dirt and moisture accumulation.
4. After carpet is installed, place a protective barrier, such as cardboard or plastic sheet, over all floor areas that will be travelled on by workers prior to the end of construction.

#### 3. Material and Product Storage

1. All porous, absorptive and finish materials are to be covered or contained prior to installation to prevent dust, dirt and moisture accumulation.
2. While in storage, materials and products shall be elevated a minimum of 4" above the floor and covered using tarps or plastic sheets.
3. Materials and products that will be installed inside the weatherproofing system must be kept dry at all times. The Contractor shall identify and remove all porous building materials that become wet or damaged by moisture within 7 calendar days of such exposure.

#### 4. Housekeeping Measures

1. Clean up accumulated debris on a daily basis.
2. Complete a comprehensive cleaning of the entire floor area on a weekly basis. Clean up shall include, at a minimum, the following activities:
  1. Remove of all unnecessary debris and waste from the building. Dispose of in accordance with Section 01 74 19.
  2. Vacuum (preferred) or sweep (using a non-toxic sweeping compound) all floor areas.
  3. Inspect storage of all materials and products for compliance.
3. Once the building is closed-in, use walk off mats at all entryways to limit the amount of dirt that is tracked into the building.
4. Keep dirt and other pollutants away from outdoor air intakes and building openings.
5. Keep mechanical rooms clean and neat. Remove excess dust and debris.

6. All standing water that accumulates on interior floors shall be removed on the day that it is observed.
5. Pathway Interruption
  1. Project equipment and material staging areas shall be located away from critical airflow pathways.
  2. Mechanical rooms and air handling equipment areas shall not be used to store construction waste or materials.
  3. Use permanent or temporary barriers to isolate areas with heavy dust generating activities from the rest of the building. Used permanent walls, doors or temporary plastic sheet barriers to isolate these areas.
  4. Establish at least one centrally located work/cutting room that is isolated from other areas of the building using permanent or temporary barriers. Carryout all heavy dust-generating activities (e.g. wood cutting) in this room. Provide temporary exhaust to the outdoors as required to maintain area at a negative pressure differential compared to surround areas.
6. Ductwork Protection
  1. Stockpiled ductwork not yet installed shall be stored in an area that is clean, dry and has minimum exposure to dust. Ductwork shall be elevated a minimum of 4" above the floor and covered using tarps or plastic sheets.
  2. During ductwork installation, the working area shall be clean, dry and protected from the exterior elements.
  3. Wipe internal surfaces of ductwork immediately prior to installation to remove dust that has accumulated.
  4. All open ductwork must be covered at the end of each day or when not being worked on to prevent the entry of debris into the duct. This can be done using plastic sheets or duct end caps.
7. HVAC Equipment Protection
  1. HVAC equipment not yet installed shall be stored in an area that is clean, dry and has minimum exposure to dust. Equipment shall be elevated a minimum of 4" above the floor and covered using tarps or plastic sheets.
  2. Seal supply diffusers and return grills with plastic during construction operations. Ensure that plastic covers remain in place until final building cleaning and prior to HVAC equipment start-up.
  3. Provide temporary exhaust to areas where heavy construction and dust generating activities are expected to take place. Exhaust systems shall be independent of the building HVAC system to minimize ductwork and equipment contamination.
  4. HVAC equipment should not be operated during construction. If temporary heating, cooling or ventilation is required, this should be done using temporary equipment. Equipment with firing sections located outside the building should be given preference over standard propane fired construction heaters.
8. Note: Should a permanent HVAC system be operated during construction, its operation shall be approved by both the LEED Consultant and Engineer. Prior to startup, the Contractor shall place temporary filters with a MERV 8 or better effectiveness over all return grills and replace all internal equipment filters prior to startup. If an un-ducted plenum over the construction zone must be used for return air, the Contractor shall ensure that all ceiling tiles are in place and that temporary filters with a MERV 8 or better effectiveness are placed over return grills in the suspended ceiling. Systems are to be shut down during heaviest periods of construction.

### 3.4 APPENDICES

1. APPENDIX A-018119 – Schedule Q1 – General Contractor Checklist & Log
2. APPENDIX B-018119 – Schedule Q2 – Mechanical Contractor Checklist & Log

END OF SECTION

## SCHEDULE Q1 – GENERAL CONTRACTOR IAQ CHECKLIST & LOG (APPENDIX A)

Complete this schedule on a weekly basis after the building reaches close-in. Submit completed schedule along with supporting digital photos to the Consultant at the end of each month.

### Weekly Checklist

Week of: \_\_\_\_\_

Complete this checklist to confirm that the following IAQ requirements were carried out within the last week:

- ☐ Smoking has not been observed within the building. "No Smoking" signs are in place.
- ☐ Toxic chemicals and fuels are stored outside of the building.
- ☐ Clean-up of accumulated debris has taken place on a daily basis.
- ☐ Within the past week, a comprehensive cleaning of the entire floor area has taken place
- ☐ All materials and products are stored in accordance with 3.3.3.
- ☐ Stockpiled ductwork is stored in accordance with 3.3.6.
- ☐ Open ductwork not in use is sealed using plastic or end caps.
- ☐ Adhesives, sealants, paints and coatings that are, or will be, installed within the building have been reviewed and approved by the Consultant in accordance with specification section 01 81 13
- ☐ Ensure the building envelope is sealed and weatherproofed.
- ☐ Electric or propane powered equipment is being used.

### Weekly Log

Complete this table by listing the types, locations and conditions of IAQ measures implemented onsite this past week.

IAQ Measure in Place	Location	Repairs Done / Required

\_\_\_\_\_  
Company Name

\_\_\_\_\_  
Contact Name

\_\_\_\_\_  
Date

☐ I have provided photo documentation supporting the information provided on this schedule.

## SCHEDULE Q2 – MECHANICAL CONTRACTOR IAQ CHECKLIST & LOG (APPENDIX B)

Complete this schedule on a weekly basis after the building reaches close-in. Submit completed schedule along with supporting digital photos to the General Contractor at the end of each month.

### Weekly Checklist

Week of: \_\_\_\_\_

Complete this checklist to confirm that the following IAQ requirements were carried out within the last week:

- ☐ Pipe and duct insulation is stored in accordance with 3.3.3.
- ☐ Stockpiled ductwork is stored in an area that is clean and dry.
- ☐ Stockpiled ductwork is elevated a minimum of 4" above the floor.
- ☐ Stockpiled ductwork is covered with tarps.
- ☐ HVAC equipment not yet installed is stored in an area that is clean and dry.
- ☐ HVAC equipment not yet installed is elevated a minimum of 4" above the floor.
- ☐ HVAC equipment not yet installed is covered with tarps.
- ☐ Open ductwork not in use is sealed using plastic or end caps.
- ☐ Diffusers and return grills are sealed with plastic.
- ☐ Mechanical rooms and air handling equipment areas are not being used to store construction waste materials.
- ☐ All interior surfaces of ductwork installed in the past week were wiped prior to installation.
- ☐ Adhesives, sealants, paints and coatings that are, or will be, installed within the building have been reviewed and approved by the Consultant in accordance with specification section 01 81 13.
- ☐ If permanent HVAC equipment is being used, temporary MERV-8 filters are placed over all return grills/ducts.

### Weekly Log

Complete this table by listing the types, locations and conditions of IAQ measures implemented onsite this past week.

IAQ Measure in Place	Location	Repairs Done / Required

\_\_\_\_\_  
Company Name

\_\_\_\_\_  
Contact Name

\_\_\_\_\_  
Date

- ☐ I have provided photo documentation supporting the information provided on this schedule.

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned; refer to Related Sections for specific commissioning requirements for individual systems and equipment.

### **1.2 RELATED REQUIREMENTS**

1. Division 01 – General Requirements:
  1. Section 01 31 19 – Project Meetings
  2. Section 01 75 16 – Start-Up Procedure
  3. Section 01 78 23 – Operation and Maintenance Data
  4. Section 01 79 00 – Demonstration and Training

### **1.3 DEFINITIONS**

1. BoD: Basis of Design.
2. CxA: Commissioning Authority.
3. DID: Design Intent Document which was prepared by the Consultant during the early stages of the project to record quantifiable design values for systems and assemblies being commissioned, and which will be used to determine whether or not the building meets the Owner's expectations.
4. OPR: Owner's Project Requirements.
5. SRC: Systems Readiness Checklist.
6. VTP: Verification Testing Procedures.
7. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
8. TAB: Testing, Adjusting, and Balancing.

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination:
  1. Coordinating Meetings: CxA is responsible to conduct biweekly coordination meetings of the commissioning team to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities in accordance with Section 01 31 19 – Project Meetings.
  2. Pre-testing Meetings: CxA is responsible to conduct pre-test meetings of the commissioning team to review Start-Up reports, pre-test inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested.
  3. Testing Coordination: CxA is responsible to coordinate sequence of testing activities to accommodate required quality assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting; schedule times for tests, inspections, obtaining samples, and similar activities.
  4. Manufacturers' Site Services: CxA is responsible to coordinate services of manufacturers' site services.
2. Commissioning Team:
  1. Members Appointed by Contractor:
    1. Individuals having authority to act on behalf of the entity they represent; explicitly organized to implement the commissioning process through coordinated actions.

2. The commissioning team shall consist of representatives of each Subcontractor, including project superintendent and sub-subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
2. Members Appointed by Owner:
  1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process; Owner will engage the CxA under a separate contract.
  2. Representatives of the facility user and operation and maintenance personnel
  3. Consultant and engineering design professionals; forward copies of supplemental instructions, requests for information, change orders, construction meeting minutes, and other pertinent construction phase documentation to CxA for the purposes of keeping the CxA informed on current project status and to verify that integrity of DID is maintained.

## 1.5 SUBMITTALS

1. Commissioning Plan Pre-final Submittal:
  1. CxA is responsible to submit two (2) hard copies of pre-final commissioning plan.
  2. Deliver one copy to Contractor, each Subcontractor, one to Owner, and one to Consultant.
  3. Present submittal in sufficient detail to evaluate data collection and arrangement process.
  4. One copy, with review comments, will be returned to the CxA for preparation of the final construction phase commissioning plan.
2. Commissioning Plan Final Submittal:
  1. CxA is responsible to submit one (1) hard copy and one (1) digital copy of the final commissioning plan to Owner and Consultant.
  2. The final submittal must address previous review comments.
  3. The final submittal shall include a copy of the pre-final submittal review comments along with a response to each item.
3. Test Checklists and Report Forms:
  1. CxA is responsible to submit sample checklists and forms to Contractor quality control manager and subcontractors for review and comment.
  2. Submit two (2) copies of each checklist and report form.
4. Certificates of Readiness: Contractor shall submit Certificates of Readiness to the CxA for review prior to the start of commissioning.
5. Test and Inspection Reports: CxA is responsible to submit test and inspection reports.
6. Corrective Action Documents: CxA is responsible to submit corrective action documents.
7. Pre-final Commissioning Report Submittal:
  1. CxA is responsible to submit two (2) hard copies of the pre-final commissioning report.
  2. Include a copy of the preliminary submittal review comments along with CxA's response to each item.
  3. CxA is responsible to deliver one copy to Owner and one copy to Consultant.
  4. One copy, with review comments, will be returned to the CxA for preparation of final submittal.
8. Final Commissioning Report Submittal:
  1. CxA is responsible to submit one (1) hard copy and one (1) digital copy of the final commissioning plan to Owner and Consultant.
  2. The final submittal must address previous review comments and shall include a copy of the pre-final submittal review comments along with a response to each item.



## 1.6 QUALITY ASSURANCE

1. Instructor Qualifications: Factory authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
2. Test Equipment Calibration:
  1. Comply with test equipment manufacturer's calibration procedures and intervals.
  2. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping.
  3. Affix calibration tags to test instruments.
  4. Instruments shall have been calibrated within six months prior to use.

## 2 Products

### 2.1 COMMISSIONING DOCUMENTATION

1. Index of Commissioning Documents: CxA is responsible to prepare an index to include storage location of each document.
2. OPR: A written document, prepared by Owner that details the functional requirements of Project and expectations of how it will be used and operated; this document includes project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information.
3. BoD Document: A document, prepared by Consultant, that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines; the document includes both narrative descriptions and lists of individual items that support the design process.
4. Commissioning Plan: A document, prepared by CxA, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:
  1. Plan for delivery and review of submittals, systems manuals, and other documents and reports including:
    1. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes
    2. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan
  2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
  3. Identification of systems and equipment to be commissioned
  4. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
  5. Identification of items that must be completed before the next operation can proceed.
  6. Description of responsibilities of commissioning team members
  7. Description of observations to be made
  8. Description of requirements for operation and maintenance training, including required training materials
  9. Description of expected performance for systems, subsystems, equipment, and controls
  10. Schedule for commissioning activities with specific dates coordinated with overall construction schedule.
  11. Identification of installed systems, subsystems, and equipment, including design changes that occurred during the construction phase
  12. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.

13. Process and schedule for completing pre-start and Start-Up checklists for systems, subsystems, and equipment to be verified and tested.
14. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.
5. Test Checklists: CxA shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested, and as follows:
  1. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required.
  2. Provide space for testing personnel to sign off on each checklist. Specific checklist content requirements are contained in the referenced commissioning specification sections; each checklist, regardless of system, subsystem, or equipment being tested shall include the following:
    1. Name and identification code of tested item.
    2. Test number.
    3. Time and date of test.
    4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
    5. Dated signatures of the person performing test and of the witness, if applicable
    6. Individuals present for test.
    7. Deficiencies.
    8. Issue number, if any, generated as the result of test.
6. Certificate of Readiness:
  1. Certificate of Readiness shall be signed by Contractor, each Subcontractor, Sub-subcontractor(s) and Installer(s), certifying that systems, subsystems, equipment, and associated controls are ready for testing and submit to the CxA for review prior to testing.
7. Test and Inspection Reports:
  1. CxA is responsible to record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data.
  2. CxA is responsible to compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.
8. Corrective Action Documents:
  1. CxA is responsible to document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any.
  2. Retest systems and equipment requiring corrective action and document retest results.
9. Issues Log:
  1. CxA is responsible to prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the OPR, BoD, and Contract Documents.
  2. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.
  3. Creating an Issues Log Entry:
    1. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
    2. Assign a descriptive title of the issue.
    3. Identify date and time of the issue.
    4. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.

5. Identify system, subsystem, and equipment to which the issue applies.
  6. Identify location of system, subsystem, and equipment.
  7. Include information that may be helpful in diagnosing or evaluating the issue.
  8. Note recommended corrective action.
  9. Identify commissioning team member responsible for corrective action.
  10. Identify expected date of correction.
  11. Identify person documenting the issue.
4. Documenting Issue Resolution:
    1. Log date correction is completed or the issue is resolved.
    2. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
    3. Identify changes to the OPR, BoD, or Contract Documents that may require action.
    4. State that correction was completed and system, subsystem, or piece of equipment is ready for retest, if applicable.
    5. Identify person(s) who corrected or resolved the issue.
    6. Identify person(s) documenting the issue resolution.
  5. Issues Log Report:
    1. On a periodic basis, but not less than for each commissioning team meeting, CxA is responsible to prepare a written narrative for review of outstanding issues and a status update of the issues log.
    2. As a minimum, CxA is responsible to include the following information in the issues log and expand it in the narrative:
      1. Issue number and title.
      2. Date of the identification of the issue.
      3. Name of the commissioning team member assigned responsibility for resolution.
      4. Expected date of correction.
10. Commissioning Report:
    1. CxA is responsible to document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment.
    2. Commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the OPR, BoD, and Contract Documents.
    3. Commissioning report shall include, but is not limited to, the following:
      1. Lists and explanations of substitutions; compromises; variances in the OPR, BoD, and Contract Documents; record of conditions; and, if appropriate, recommendations for resolution:
        1. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation.
        2. It shall describe components and performance that exceed requirements of the OPR, BoD, and Contract Documents and those that do not meet requirements of the OPR, BoD, and Contract Documents.
        3. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
      2. OPR and BoD documentation.
      3. Commissioning plan.
      4. Testing plans and reports.
      5. Corrective modification documentation.
      6. Issues log.
      7. Completed test checklists.
      8. Listing of off-season test(s) not performed and a schedule for their completion.

## 2.2 ENHANCED COMMISSIONING SYSTEMS MANUAL

1. Systems Manual: CxA is responsible to gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:
  1. Final version of the BoD.
  2. System single-line diagrams.
  3. As-built sequences of operations, control drawings, and original set points.
  4. Operating instructions for integrated building systems.
  5. Recommended schedule of maintenance requirements and frequency, if not already included in the project O&M manuals.
  6. Recommended schedule for retesting of commissioned systems with blank test forms from the original commissioning plan.
  7. Recommended schedule for calibrating sensors and actuators.

## 3 Execution

### 3.1 RESPONSIBILITIES

1. Owner's Responsibilities: Provide the OPR documentation to the CxA and Contractor for use in developing the commissioning plan; systems manual; operation and maintenance training plan; and testing plans and checklists and as follows:
  1. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
    1. Coordination meetings.
    2. Training in operation and maintenance of systems, subsystems, and equipment.
    3. Testing meetings.
    4. Demonstration of operation of systems, subsystems, and equipment.
  2. Provide the BoD documents prepared by Consultant and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
2. Contractor's Responsibilities: Provide utility services required for the commissioning process and as follows:
  1. Contractor will assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
    1. Participate in design and construction phase coordination meetings.
    2. Participate in maintenance orientation and inspection.
    3. Facilitate operation and maintenance training sessions, organize location and schedule, and organize training program.
    4. Participate in final review at acceptance meeting.
    5. Certify that Work is complete, and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
    6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
    7. Review and approve final commissioning documentation.
    8. Develop commissioning schedule based on commissioning scope, coordinate with construction schedule and update prior to each commissioning meeting.
    9. Videotape and edit training sessions.
  2. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
    1. Participate in design and construction phase coordination meetings.
    2. Participate in maintenance orientation and inspection.

3. Participate in procedures meeting for testing.
  4. Participate in final review at acceptance meeting.
  5. Provide schedule for operation and maintenance data submittals, equipment Start-Up, and testing to CxA for incorporation into the commissioning plan.
  6. Provide input to update commissioning schedule prior to each commissioning meeting.
  7. Provide information to the CxA for developing construction phase commissioning plan.
  8. Provide operation and maintenance training on installed systems, organize required instructors and manufacturer's representatives, and schedule training sessions.
  9. Submit an operation and maintenance data manual to the CxA prior to commissioning, as specified in Section 01 78 23 – Operation and Maintenance Data; Manual may be in draft form to facilitate Commissioning Schedule.
  10. Provide technicians who are familiar with the construction and operation of installed systems and who will develop specific test procedures and participate in testing of installed systems, subsystems, and equipment.
3. CxA's Responsibilities: Organize and lead the commissioning team and as follows:
1. Prepare a construction phase commissioning plan.
  2. Collaborate with Contractor and with Subcontractors to develop test and inspection procedures:
    1. Include design changes and assist with development of commissioning activities schedule coordinated with overall Project schedule.
    2. Identify commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.
  3. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BoD.
  4. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes in accordance with requirements listed in Section 01 31 19 – Project Meetings:
    1. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants.
    2. The CxA is responsible to prepare and distribute minutes to commissioning team members and attendees within five (5) work days of the commissioning meeting.
  5. At the beginning of the construction phase, conduct an initial construction phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.
  6. Inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair in addition to compliance with the OPR, BoD, SRC, VTP and Contract Documents; submit Issues Log Report based on these inspections.
  7. Prepare project specific test and inspection procedures and checklists.
  8. Witness, and document tests, inspections, and systems Start-Up.
  9. Compile test data, inspection reports, and certificates and include them in the commissioning report.
  10. Certify date of acceptance and Start-Up for each item of equipment for start of warranty periods.
  11. Review and comment on operation and maintenance documentation for compliance with the OPR, BoD, and Contract Documents; operation and maintenance documentation requirements are specified in Section 01 78 23 – Operation and Maintenance Data.
  12. Prepare commissioning reports.
  13. Assemble the final commissioning documentation, including the commissioning report.
4. CxA's Responsibilities – Enhanced Commissioning: Review and comment on submittals from Contractor for compliance with the OPR, BoD, Contract Documents, and construction phase commissioning plan.

### **3.2 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS**

1. Training Preparation Conference:
  1. Before operation and maintenance training, CxA is responsible to convene a training preparation conference to include Owner's operation and maintenance personnel, Contractor, each Subcontractor, and subcontractors.
  2. In addition to requirements specified in Section 01 79 00 – Demonstration and Training, perform the following:
    1. Review the OPR and BoD.
    2. Review installed systems, subsystems, and equipment.
    3. Review instructor qualifications.
    4. Review instructional methods and procedures.
    5. Review training module outlines and contents.
    6. Review course materials (including operation and maintenance manuals).
    7. Review and discuss locations and other facilities required for instruction.
    8. Review training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
    9. Coordinate Systems Training provided by Design Team.

### **3.3 VERIFICATION TESTING**

1. CxA will coordinate, conduct, and witness all system verification tests to verify that the systems operate in accordance with the design intent; Contractor shall be responsible for performing the verification tests and operating the systems during commissioning.
2. Any system deficiencies discovered during verification testing will be documented and logged by the CxA and identified for corrective action; retesting specific systems or system components will take place once the respective deficiencies discovered during the first test are resolved.
3. Coordinate with requirements of individual Technical Specification Sections for detailed requirements relating to verification testing.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section includes the following:
  1. Demolition and removal of selected portions of exterior building components or structural elements
  2. Demolition and removal of selected site elements.
2. This section does not include the following:
  1. Removal of hazardous materials or asbestos abatement.
  2. Demolition of interior building components and finishes.
3. Drawings contain details that suggest directions for solving some of the major demolition and removal requirements for this project; Contractor is required to develop these details further by submitting a demolition plan prepared by a professional engineer employed by the Contractor.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. American National Standards Institute (ANSI)/American Society of Safety Professional (ASSP):
  1. ANSI/ASSP A10.8-2019, Scaffolding Safety Requirements
2. Canadian Federal Legislation:
  1. Motor Vehicle Safety Act (MVSA), 1995
  2. Hazardous Materials Information Review Act, 1985
3. Canadian Standards Association (CSA):
  1. CSA S350- M1980 (R2003), Code of Practice for Safety in Demolition of Structures
4. National Fire Protection Association (NFPA):
  1. NFPA 241-2022, Standard for Safeguarding Construction, Alteration, and Demolition Operations

### **1.4 DEFINITIONS**

1. Demolish: Detach items from existing construction and legally dispose of them off site, unless indicated to be removed and salvaged or removed and reinstalled.

### **1.5 ADMINSTRATIVE REQUIREMENTS**

1. Pre-Demolition Meeting: Conduct a pre-demolition meeting at Project site in accordance with requirements listed in Section 01 31 19 – Project Meetings, to confirm extent of demolished materials and to review Contractor's demolition plan prepared by a professional engineer.
2. Coordination: Arrange selective demolition schedule so as not to interfere with Owner's operations.

### **1.6 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:

1. Demolition Plan: Submit a plan of demolition area indicating extent of temporary facilities and supports, methods of removal and demolition prepared by a professional engineer registered in the Province of Ontario and in accordance with requirements of Authority Having Jurisdiction, and as follows:
  1. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Consultant reserves the right to make modifications where proposed methods interfere with the Owner's ongoing operations.
  2. Pre-demolition Photographs: Submit photographs indicating existing conditions of adjoining construction and site improvements prior to starting Work. Include finish surfaces that may be misconstrued as damage caused by selective demolition operations.
3. Informational Submittals: Provide the following submittals when requested by the Consultant:
  1. Qualification Data: Submit information for companies and personnel indicating their capabilities and experience to perform work of this Section including, but not limited to, lists of completed projects with project names and addresses, names and addresses of architects and owners, for work of similar complexity and extent.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.7 QUALITY ASSURANCE

1. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project:
  1. Conform to the Ontario Occupational Health and Safety Act and Regulations.
  2. Conform to Workers' Compensation Board Regulations.
  3. Conform to the applicable bylaws and regulations governing this type of work.
2. Standards: Comply with regulations of local authorities having jurisdiction and standards referenced in this Section. Where differences occur between the local regulations and referenced standards, the most restrictive requirement shall govern.

#### 1.8 SITE CONDITIONS

1. Owner Occupancy: Owner will occupy portions of building immediately adjacent to selective demolition area:
  1. Conduct selective demolition so that Owner's operations will not be disrupted.
  2. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.
2. Site Access: Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities, and as follows:
  1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Authorities Having Jurisdiction.
3. Existing Conditions: Owner assumes no responsibility for condition of areas to be selectively demolished:
  1. Conditions existing at time of Pre-Bid Site Review will be maintained by Owner as far as practical.
  2. Notify Consultant of discrepancies between existing conditions and Drawings before starting selective demolition.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.



1. Hazardous materials will be as defined in the Hazardous Materials Act.
2. Hazardous materials will be removed by Owner before start of the Work.
3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Consultant and Owner. Hazardous materials will be removed by Owner under a separate contract or as a change to the Work.

## **2 Products**

### **2.1 PERFORMANCE REQUIREMENTS**

1. Regulatory Requirements: Comply with governing environmental notification requirements and regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

## **3 Execution**

### **3.1 EXAMINATION**

1. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
2. Notify the Consultant where existing elements conflict with intended function or design:
  1. Investigate and measure the nature and extent of conflict and submit a written report to Consultant.
  2. Consultant will issue additional instructions or revise drawings as required to correct conflict.
3. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

### **3.2 SELECTIVE DEMOLITION**

1. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations, and as follows:
  1. Do not allow demolished materials to accumulate onsite.
  2. Dispose of demolished items and materials promptly.
  3. Remove items indicated on Drawings. Do not disturb items identified to remain in place.
  4. Demolish pavement, curbs, and gutters to extents indicated on Drawings.
  5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  6. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  7. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  8. Comply with requirements specified in Section 01 74 19 – Construction Waste Management.

### **3.3 SITE QUALITY CONTROL**

1. Patching and Repairs: Promptly repair damage to adjacent construction caused by selective demolition operations

### **3.4 CLOSEOUT ACTIVITIES**

1. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of masonry mortar and grout used to construct concrete unit masonry partitions and assemblies.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM C207-18, Standard Specification for Hydrated Lime for Masonry Purposes
  2. ASTM C143/C143M-20, Standard Test Method for Slump of Hydraulic-Cement Concrete
  3. ASTM C494/C494M-19e1, Standard Specification for Chemical Admixtures for Concrete
  4. ASTM C1384-18e1, Standard Specification for Admixtures for Masonry Mortars
3. Canadian Standards Association (CSA Group):
  1. CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
  2. CAN/CSA A179-14 (R2019), Mortar and Grout for Unit Masonry
  3. CAN/CSA A371-14 (R2019), Masonry Construction for Buildings
  4. CSA A3000-18, Cementitious Materials Compendium
4. International Masonry Industry All-Weather Council (IMIAC)
  1. Recommended Practices and Guide Specifications for Cold Weather Masonry Construction

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, the Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to masonry mortar and grout including, but not limited to, the following:
  1. Confirmation of specifications and details for the project.
  2. Required mortar and grout testing and batch control.
2. Coordination: Coordinate joint profiles with Consultant prior to starting any Work of this Section.

### **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including mixing and preparation instructions and recommendations and installation methods.
3. Informational Submittals: Provide the following submittal during the course of the Work:
  1. Certificates: Submit statements of material properties indicating compliance for the following:
    1. Include brand, type, and name of manufacturer for mortar materials.
    2. Include description of type and proportions of ingredients for mortar and grout.
  2. Source Quality: Submit mix designs for each type of mortar and grout including descriptions of type and proportions of ingredients, and as follows:

1. Obtain mortar and grout ingredients of a uniform quality and colour for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate; select ingredients to reduce the potential for efflorescence and submit mix design information as indicated.
  2. Include test reports for mortar and grout mixes compressive strength, water retention, and air content requirements in accordance with Proportion Specification described in CAN/CSA A179.
  3. Include confirmation that mortar, and grout materials used for the Project have lower potential for developing efflorescence.
  4. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements specified in this Section.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.6 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance: Deliver mortar and grout materials to site in original factory packaging, labelled with manufacturer's name and product information.
2. Storage and Handling: Store mortar and grout materials in clean, dry, and protected from freezing, traffic, and contamination in accordance with manufacturer's storing recommendations.

#### 1.7 SITE CONDITIONS

1. Ambient Conditions: Install masonry mortar and grout in accordance with weather protection requirements and withing temperature limitations indicated in CAN/CSA A371.

### 2 Products

#### 2.1 MASONRY MORTAR

1. Cementitious mortar in accordance with CAN/CSA A179 using one of the following at choice of Contractor, and as follows:
  1. Portland Cement-Lime Mortar:
    1. Cement: To CSA A3000, Type 10 Normal Portland Cement.
    2. Hydrated Lime: To ASTM C207, Type S.
  2. Masonry Cement or Mortar Cement: To CSA A3000.
  3. Portland Cement with Masonry Cement or Portland Cement with Mortar Cement: Use materials described above and in accordance with CSA A3000.
  4. Mortar Aggregates: To CAN/CSA A179, and as follows:
    1. Use washed aggregate consisting of natural sand or crushed stone for mortar that is exposed to view.
    2. Use aggregate graded with 100 percent passing 1.18-mm sieve for joints less than 6 mm thick.
    3. Use aggregates that have low potential for efflorescence, provide test results indicating that materials used for the project meet requirements specified.
2. Admixtures: Non-chloride, non-corrosive, accelerating admixture in conformance with ASTM C1384, recommended by the manufacturer for use in masonry mortar specified and posing no adverse effect on the mortar performance.
3. Water: Clean and potable water in accordance with CAN/CSA A179 and CAN/CSA A23.1/A23.2.

#### 2.2 MASONRY GROUT

1. Cement: To CSA A3000, Type 10 Normal Portland Cement.
2. Grout Aggregates: Fine and coarse aggregated in accordance with CAN/CSA A179.

3. Admixtures: To ASTM C494/C494M and posing no adverse effect on the grout performance.
4. Water: Clean and potable water in accordance with CAN/CSA A179.

### 2.3 MASONRY MORTAR MIX

1. Mortar Mix Design Requirements: Factory blended hydraulic cement-lime mix proportioned to produce masonry mortar mix in accordance with CAN/CSA A179 and CAN/CSA A23.1/A23.2.-
2. Trowel Ready (Wet Premix) Mortar: Batch and mix materials in accordance with CAN/CSA A179, at an acceptable batch plant; hand mixing will only be permitted when accepted in writing by Consultant for small site mixed quantities.
3. Mortar Types: To CAN/CSA A179, Proportion Specification. Using combination of materials described in this Section, and as follows:
  1. Mortar for Reinforced Masonry: Use Type S.
  2. Mortar for Interior Masonry:
    1. Loadbearing Masonry Walls: Use Type S.
    2. Non-Loadbearing Masonry Walls: Use Type N.
  3. Pointing Mortar: Use Type to match mortar used within assembly.

### 2.4 MASONRY GROUT MIX

1. Masonry Grout Mix: To CSA A23.1/A23.2 and CAN/CSA A179, Proportion Specification, having a minimum compressive strength as follows:
  1. 10 MPa at 28 days for fine aggregate.
  2. 12.5 MPa at 28 days for coarse aggregate.
2. Provide grout with a slump of minimum 200 to a maximum 280 mm in accordance with ASTM C143/C143M, adjust water content of grout mix design to account for absorption rate of masonry units used for the Project.
3. Wet Premix Grout for Unit Masonry: Batch and mix materials in accordance with CAN/CSA A179, at an acceptable batch plant; hand mixing will only be permitted when accepted in writing by the Consultant for small site mixed quantities.

### 2.5 ACCESSORIES

1. Masonry Anchorage and Reinforcing: Refer to Section 04 05 19 – Masonry Anchorage and Reinforcement.
2. Masonry Accessories: Refer to Section 04 15 00 – Masonry Accessories.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

1. Mortar Bedding and Jointing: Install mortar in accordance with CAN/CSA A179, and in accordance with manufacturer's instructions.
2. Mortar Joint Tooling:
  1. Tool mortar joints when they are thumbprint hard to provide the greatest resistance to water penetration and to help minimize hairline cracks between mortar and masonry.
  2. Tool mortar joints to profile indicated in Section 04 21 13 – Brick Masonry Veneer.

3. Install grout in accordance with manufacturer's written instructions, CAN/CSA A179, and as follows:
  1. Do not place grout until the entire height of masonry to be grouted has reached enough strength to resist grout pressure.
  2. Fill vertical cores, beams, posts, and lintels in masonry units with concrete grout in accordance with CAN/CSA A371 and where reinforcing steel is indicated on Drawings.
  3. Limit height of vertical grout pours to not more than 1520 mm.

### 3.3 CLOSEOUT ACTIVITIES

1. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar and grout. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
2. Cleaning: After mortar and grout is thoroughly set and cured, clean exposed masonry as follows:
  1. Remove large mortar and grout particles by hand with wooden paddles and non-metallic scrape hoes or chisels.
  2. Remove mortar and grout droppings and splashings using clean sponge and water.
  3. Clean masonry with low pressure clean water and soft natural bristle brush prior to Substantial Performance of the Work.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements for design, supply, and installation of masonry anchorage and reinforcement including ties and connectors required to construct concrete unit masonry partitions and assemblies.
2. This Section specifies performance criteria for design of seismic restraint and anchorage relating to masonry assemblies and requires proof of engineered solutions in the form of the shop drawings and product data submittals acceptable to the Authorities Having Jurisdiction (AHJ).

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A36/A36M-19, Standard Specification for Carbon Structural Steel
  2. ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  3. ASTM 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 and Studs, 60 000 PSI Tensile Strength
  5. ASTM A563/A563M-21a<sup>1</sup>, Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric)
  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 A1064/A1064M-22, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
  8. ASTM B633-23, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  9. ASTM E488/E488M-22, Standard Test Methods for Strength of Anchors in Concrete Elements
  10. ASTM F593-22, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
  11. ASTM F594-22, Standard Specification for Stainless Steel Nuts
  12. 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
3. Canadian Concrete Masonry Producers' Association (CCMPA):
  1. Seismic Design Guide for Masonry Buildings, Second Edition
4. Canadian Standards Association (CSA Group):
  1. CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
  2. CSA A370-14 (R2018), Connectors for Masonry
  3. CAN/CSA A371-14 (R2019), Masonry Construction for Buildings
  4. CSA G30.18:21, Carbon Steel Bars for Concrete Reinforcement

5. CSA S304-14 (R2019), Design of Masonry Structures
5. Reinforcing Steel Institute of Canada (RSIC):
  1. Manual of Standard Practice, 2020

#### 1.4 ADMINISTRATIVE REQUIREMENTS

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, the Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to masonry anchorage and reinforcement including, but not limited to, the following:
  1. Confirmation of specifications and details for the project.
  2. Coordination for placement of masonry anchorage and reinforcement with air and vapour membranes, cavity insulation, and other components of the Work.
  3. Confirmation of reinforcement at corners and wall intersections.
  4. Coordination of interior and exterior crack control measures.
2. Coordination: Coordinate components of the work of this Section with work performed by other Section including steel support angles, brackets, and anchors specified in Section 05 50 00 – Metal Fabrications.

#### 1.5 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including manufacturer's written instructions, printed literature and data sheets for anchorage and reinforcement materials describing product characteristics, performance criteria, physical size, finish, and limitations.
  2. Shop Drawings: Submit shop drawings indicating shelf angle size and thickness, bracket sizing and spacing, and fastening system, reinforcing steel bending charts and lists, anchorage details, and placement details with spacing and location of reinforcement connectors.
3. Informational Submittals: Provide the following submittal during the course of the Work:
  1. Certificates: Submit statements of material corrosion properties indicating compliance with specified requirements for each type and size of the following:
    1. Reinforcing bars.
    2. Joint reinforcement.
    3. Anchors, ties, and metal accessories.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.6 SITE CONDITIONS

1. Ambient Conditions: Install masonry anchorage and reinforcement in accordance with weather protection requirements and within temperature limitations described in CAN/CSA A371.

## 2 Products

### 2.1 PERFORMANCE REQUIREMENTS

1. Seismic Response Characteristics: Design anchorages and connectors for non structural assemblies and components in accordance with Ontario Building Code (OBC); and as follows:
  1. Anchorage, Bracing and Seismic Restraints: Design anchorage and connectors to withstand seismic forces outlined in the OBC for post disaster facilities.

2. Seismic Loading: Base seismic performance on full uniform load acceleration of 0.246 g and velocity of 0.133 m/s in accordance with CSA S304 and CCMPA Seismic Design Guide for Masonry Buildings.

## 2.2 MASONRY SUPPORTS (VENEER SHELF ANGLES)

1. Shelf Angle Support System: Pre-manufactured, 3-way adjustable angle support system comprised of brackets, anchorage system, shelf angles and fastenings meeting requirements of CSA A370 and CSA S304 with galvanized corrosion protection based on exposure environment, and as follows:
  1. Bracket Depth and Thickness: Fill wall cavity that allows for continuous insulation behind support angle, sized in accordance with manufacturers requirements.
  2. Bracket Height: Sized to meet anchor to shelf angle clearance distance.
  3. Support Angle Size and Thickness: Sized for brick loading condition in accordance with manufacturer's requirements.
  4. Fasteners: Post-installed corrosion resistant screws meeting requirements of CSA A370 and as recommended by shelf angle support system manufacturer based on substrates being fastened into.
  5. Accessories: As required by manufacturer for installation condition and substrate composition.
  6. Basis-of-Design Products: FAST Thermal Bracket by FERO Corporation.

## 2.3 MASONRY CONNECTORS (VENEER TIES)

1. Multi-component proprietary connector systems meeting performance requirements described in CSA A370 and CSA S304, fabricated from hot-rolled sheet steel meeting requirements of ASTM A1011/A1011M Class CS, and as follows:
  1. Veneer Type: Unit masonry veneer as indicated on Drawings.
  2. Corrosion Protection: Hot dip galvanized in accordance with ASTM A123/A123M with corrosion protection in accordance with CSA S304 and CSA A370 for exposure environment.
  3. Mounting Configuration: Face of substrate.
  4. Mounting Plate: Designed to transfer wind loads to substrate based on mounting configuration; length to accommodate total cavity width and attachment requirements.
  5. Ties: Hot-dip galvanized wire in accordance with to CAN/CSA A371 and ASTM A1064/A1064M, Grade 400 or hot-rolled steel sheet in accordance ASTM A1011/A1011M based on manufacturers loading requirements, with corrosion protection in accordance with CSA S304 and CSA A370 for exposure environment.
  6. Insulation Clips: Manufacturer's standard insulation retention device.
  7. Fasteners: Self tapping corrosion resistant screws meeting requirements of CSA A370 and as recommended by tie manufacturer based on substrates being fastened into.
  8. Basis-of-Design Products: FERO Corporation, Thermal Tie – Heavy-Duty Holed Rap-Tie.

## 2.4 MASONRY ANCHORS

1. Rigid T-Intersection Anchors: Fabricate from steel bars 38 mm wide x 6 mm thick x 600 mm long with ends turned up 50 mm or with cross pins at installers option; hot dip galvanized.
2. Anchor Bolts: Headed or L-shaped steel bolts in accordance with ASTM A307 and ASTM F3125/F3125M Grade A; with ASTM A563/A563M hex nuts and, where indicated, flat washers; hot-dip galvanized in accordance with ASTM A153/A153M, Class C.
3. Post Installed Anchors: Provide chemical and torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete when tested in accordance with ASTM E488/E488M, and as follows:



1. Indoor Locations: Carbon-steel components zinc-plated in accordance with ASTM B633, Class Fe/Zn 5.
2. Exterior and High Humidity Locations: Alloy Group 1 or 2 stainless steel bolts complying with ASTM F593 and nuts complying with ASTM F594.
3. Fastening into Solid Concrete or Solidly Grouted CMU Installations: Two component, injectable adhesive specifically manufactured for use in installing dowels or threaded anchor rods and inserts into new or existing concrete or grout, and as follows:
  1. Epoxy Composition: Sealed packaging containing resin, hardener, cement, and water; components.
  2. Curing Time: Rapid set, high strength, and stiffness; maximum time 45 minutes at 20°C.
  3. Basis-of-Design Products: HIT HY200 System by Hilti.
4. Fastening Trough Hollow Wall Installation: Two component, injectable adhesive specifically manufactured for use in installing dowels or threaded anchor rods and inserts, with cylindrical mesh screen tube into new or existing masonry cavity wall, and as follows:
  1. Epoxy Composition: Sealed packaging containing resin, hardener, cement, and water.
  2. Curing Time: Rapid set, high strength, and stiffness; maximum time 60 minutes at 20°C.
  3. Basis-of-Design Products: HIT HY70 System by Hilti.
5. Fastening to Hollow Wall Installation: Two component, injectable adhesive specifically manufactured for use in installing dowels or threaded anchor rods and inserts, with cylindrical mesh screen tube into new or existing masonry cavity wall, and as follows:
  1. Epoxy Composition: Sealed packaging containing resin, hardener, cement, and water.
  2. Curing Time: Rapid set, high strength, and stiffness; maximum time 60 minutes at 20°C.
  3. Basis-of-Design Products: HIT HY70 System by Hilti.
4. Toggle Bolts: Tumble wing type, class and style as required for supported construction.

## 2.5 MASONRY REINFORCEMENT

1. Reinforcing Bars: Deformed bars in accordance with CAN/CSA A371 and CSA G30.18, Grade 400 with galvanized corrosion protection in accordance with CSA S304 and CSA A370 for exposure environment.
2. Masonry Joint Reinforcement: In accordance with to CAN/CSA A371 and ASTM A1064/A1064M, Grade 400, with galvanized corrosion protection in accordance with CSA S304 and CSA A370 for exposure environment, and as follows:
  1. Type: Ladder or Truss Type, based on installation condition.
  2. Wire Size: Nominal 3.65 mm diameter.
  3. Cross Wire/Truss Panel Spacing: At a maximum of 400 mm O/C.
  4. Lengths: A minimum of 3000 mm, with prefabricated corner and tee units.
  5. Configuration: Single Wythe Masonry Joint Reinforcement.
3. Reinforcing Connectors: Prefabricated connectors meeting requirements of CSA A370 and CSA S304 with galvanized corrosion protection based on exposure environment, matching reinforcing steel and joint reinforcement.
  1. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in centre of cells and as follows:
  2. Fabricate wire units are formed from 3.6 mm diameter steel wire, hot dip galvanized after fabrication.
  3. Acceptable Products Manufacturers:
    1. Heckmann Building Products Inc.
    2. Hohmann & Barnard Inc.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Direct and coordinate placement of metal anchors for masonry assemblies supplied to other Sections.

#### 3.3 INSTALLATION

1. Install masonry anchorage and reinforcement in accordance with CSA A23.1/23.2, CSA A370, CAN/CSA A371, and CSA S304, modified by manufacturer's written installation instructions to accommodate site installation requirements, and as follows:
  1. Seismic Zones: Install masonry anchorage and reinforcement in accordance with CSA S304 and manufacturer's requirements for seismic restraint.
2. Install connectors and ties with vertical and horizontal offsets in accordance with CAN/CSA A371 at a maximum 800 mm horizontal O/C and 600 mm vertical O/C, and as follows:
  1. Provide additional ties within 300 mm of openings and space at a maximum of 900 mm apart around perimeter of openings.
  2. Install additional ties at intersecting and abutting walls at a maximum of 600 mm vertically on-centre.
  3. Use adjustable ties to allow for differential movement regardless of whether bed joints align to allow for differential movement between the veneer and substrate.
3. Install masonry joint reinforcement at full lengths of longitudinal side rods in mortar with a minimum cover of 16 mm on exterior side of walls and 13 mm in other locations in accordance with CAN/CSA A371, and as follows:
  1. Lap reinforcement a minimum of 150 mm, and as follows:
    1. Space reinforcement at a maximum of 400 mm O/C.
    2. Install reinforcement at a maximum of 200 mm above and below wall openings and extending 300 mm beyond openings.
  2. Interrupt joint reinforcement at control and expansion joints.
  3. Provide continuity at wall intersections by using prefabricated T-shaped units.
  4. Provide continuity at corners by using prefabricated L-shaped units.
4. Anchoring Masonry to Structural Members: Anchor masonry to structural members where masonry abuts or faces structural members as follows:
  1. Provide a minimum of 19 mm wide open space between masonry and structural member.
  2. Keep open space free of mortar and other rigid materials.
  3. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
  4. Space anchors at a maximum of 600 mm vertically on-centre and 900 mm horizontally on-centre.
5. Ties to Structure: Install welded anchors with adjustable wire ties, at 400 mm O/C; vertically for columns, horizontally for beams, where masonry walls abut or pass steel structural members.
6. Chemical Anchors: Coordinate work with Contractor for work that forms a part of this Section, install anchors in accordance with manufacturer's written instructions, and as follows:

1. Drill and clean anchor holes in accordance with manufacturer's instructions; insert screen tube, prepare, and mix two-part adhesive anchor system and fill holes; insert connector pins and twist to ensure that adhesive is in contact with connector pin.
2. Do not adjust connector pins after gel time of adhesive occurs.
3. Testing: Verify pull out resistance as described below.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of masonry accessories used to construct unit masonry assemblies as indicated on Drawings.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A240/A240M-23a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  2. ASTM C920-18, Standard Specification for Elastomeric Joint Sealants
3. Canadian Standards Association (CSA Group):
  1. CAN/CSA A371-14 (R2019), Masonry Construction for Buildings
  2. CSA A123.3-05 (R2015), Asphalt Saturated Organic Roofing Felt
  3. CSA S304-14 (R2019), Design of Masonry Structures

### **1.4 DEFINITIONS**

1. Concealed Flexible Flashings: Waterproof material used in masonry wall construction used to contain and direct water penetrating the wall system and promote drainage to the exterior of building enclosures, and typically located at the following:
  1. Cap flashings under copings.
  2. Cavity wall flashing.
  3. Foundation sill flashing.
  4. Head flashings.
  5. Sill and pan flashings.
  6. Openings perimeter flashings.
  7. Transition flashings.
  8. Through wall flashings.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, the Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to masonry accessories including, but not limited to, the following:
  1. Confirmation of specifications and details for the project.
  2. Installation requirements of air and vapour membranes and insulation and coordination with other components of the Work.
  3. Confirmation of cavity compartmentalization and drainage requirements.
2. Coordination: Coordinate sheet metal flashings and trims performed by other Sections including the following:
  1. Coordinate installation of premanufactured reglets required for sheet metal flashings supplied by Section 07 62 00 – Sheet Metal Flashing and Trim.
  2. Coordinate installation of prefinished sheet metal through flashings with Section 07 62 00 – Sheet Metal Flashing and Trim.

3. Coordinate installation of continuous aluminum flashings with Section 08 41 13 – Aluminum Framed Entrances and Storefronts.

## 1.6 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including manufacturer's written instructions, printed literature, and data sheets.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 2 Products

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 EMBEDDED FLASHING

1. Concealed Flexible Flashings: Stainless steel, 0.5 mm thickness foil, meeting requirements of ASTM A240/A240M, Type 304 backed with self-adhering butyl co-polymer adhesive with release paper, and as follows:
  1. Termination Bar: Rigid PVC or stainless-steel continuous termination bar with sealant lip and fasteners as standard to flexible flashings manufacturer.
  2. Splice Tapes: self-adhering stainless-steel tape of same type and manufacturer as concealed flexible flashings.
  3. Vent Layer: Non-woven drainage fabric laminated to stainless steel facer for through wall, venting and shelf angle locations.
  4. Sealant: Mastic type, 100% solids having no VOCs silyl-terminated polyether (STPE) meeting requirements of ASTM C920, Type S, Grade NS, Class 50, and as follows:
    1. Acceptable Products:
      1. MasterSeal NP 150 by Sika Canada Inc.
      2. R-Guard by PROSOCO Inc.
      3. UniverSeal US-100 by York Flashings.
  5. Compatibility: Surface tolerant and compatible with materials specified in with Section 07 27 16 – Air Barrier Membrane, spray applied foam insulation, plastic board insulation, gypsum sheathing, plywood, concrete, and metals.
  6. Drip Edge: Stainless steel, and as follows:
    1. Acceptable Products:
      1. Vapro-SS Flashing by VaproShield.
      2. YorkShield 304 SS by York Flashings.
2. Exposed Metal Flashings: Provide pre-finished metal flashing materials in accordance with Section 07 62 00 – Sheet Metal Flashing and Trim.
3. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

### 2.3 JOINT FILLERS

1. Movement Joint Filler: Pre-moulded compressible filler strips formulated from foamed polyethylene or urethane to maintain joints free from mortar droppings and debris.
2. Bond Breaker Strips: #15 asphalt saturated, organic roofing felt in accordance with CSA A123.3.

### 2.4 WEEPS AND VENT INSERTS

1. Cellular Plastic Weep/Vent Inserts: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 3 mm less than depth of outer wythe; colour selected by Consultant to match mortar colour, and as follows:
  1. Acceptable Products:
    1. CellVent by Mortar Net Solutions.
    2. Cell Vents (85) by Heckmann Building Products.
    3. QV – Quadro-Vent by Hohmann & Barnard Inc.

### 2.5 CAVITY DRAINAGE INSERTS

1. Cavity Drainage Inserts: Premanufactured cavity insert, sized for width of cavity designed to offset or stagger the accumulation of mortar droppings to reduce risk of clogging vents or weeps, and as follows:
  1. Acceptable Products:
    1. MortarNet by Mortar Net Solutions.
    2. Mortar Trap by Hohmann & Barnard Inc.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

1. Manufacturers' Written Instructions: Install masonry accessories in accordance with CSA S304 and CAN/CSA A371, modified by manufacturer's written instructions to accommodate site installation requirements.
2. Flashings: Install embedded concealed flashings at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where specifically indicated on Drawings, and as follows:
  1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing.
  2. Place through wall flashing on sloping bed of mortar and cover with mortar where flashing is within mortar joint.
  3. Seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer before covering with mortar.
  4. Extend flashing through veneer, across air space behind veneer, and up face of inner wythe or substrate a minimum of 200 mm; with upper edge lapped under membrane air and vapour retarder lapping a minimum of 100 mm.
  5. Extend flashing a minimum of 150 mm into masonry at each end of lintels and shelf angles.
  6. Extend flashing 150 mm at ends and turn up a minimum of 50 mm to form end dams at heads and sills.
  7. Install flashing termination beneath flexible flashing at exterior face of wall; stop flexible flashing 13 mm back from outside face of wall and adhere flashing to top of metal drip flashing termination.

8. Install reglets and nailers for flashing and other related construction when they are required for installation of items built into masonry.
3. Weep Slots: Install weep slots in head joints in exterior wythes of first course of masonry immediately above embedded flashing; use premanufactured inserts to form weep slots, spaced as follows:
  1. Space weep slots formed from premanufactured inserts at a maximum of 400 mm O/C.
4. Cavity Vents: Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and as follows:
  1. Install vents in head joints in exterior wythes at same spacing as indicated for weep slots at top of wall and immediately below any cavity obstruction.
  2. Use same methods to form vents as weep slots listed above.
5. Cavity Compartmentalization: Close cavities off vertically and horizontally with blocking as follows:
  1. Form cavity break using insulation cut to match full depth of cavity adding thickness of wall insulation x minimum 50 mm wide.
  2. Butter back face of insulation strip with adhesive and apply directly to face of air and vapour retarder.
  3. Install adjacent panels tight to sides of vertical insulation strip using 89 mm galvanized nails at 400 mm O/C pressed into insulation diagonally so that the vertical strip is attached to the insulation panels on each side.
  4. Take care not to damage or penetrate the air and vapour retarder membrane with nails.
  5. Apply sealant to front face of insulation strip and press veneer masonry into sealant to form tightly sealed pressure equalization compartments.
  6. Install through wall flashing and weep slots above, and cavity vents below horizontal blocking.
  7. Locate vertical cavity breaks not exceeding 12 m o/c.
  8. Close cavities off vertically within 600 mm each side of corners and at all vertical block control joints.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies the requirements for the supply and installation of brick masonry veneer.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. Brick Institute Association (BIA):
  1. BIA Technical Notes 20, Cleaning Brickwork
  2. BIA Technical Notes 23A, Efflorescence, Causes and Prevention
3. Canadian Standards Association (CSA Group):
  1. CAN/CSA A82.1-M87 (R2003), Burned Clay Brick (Solid Masonry Units Made From Clay or Shale)
  2. CAN/CSA A371-14 (R2019), Masonry Construction for Buildings

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, the Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to the installation of brick masonry veneer.
2. Coordination: Coordinate components of the work of this Section with work performed by other Sections including the following:
  1. Rain Screen Wall Construction:
    1. Brick masonry veneer forms a part of the exterior rain screen and protective facing.
    2. Construct assembly to allow for ventilation, drainage, and pressure equalization of void space between veneer and insulation.
  2. Sheet Metal Flashings and Trim:
    1. Coordinate installation of concealed flexible flashings forming a part of brick masonry veneer in accordance with Section 04 15 00 – Masonry Accessories.
    2. Coordinate installation of prefinished sheet metal flashings with Section 07 62 00 – Sheet Metal Flashing and Trim.

### **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified.
  2. Shop Drawings: Submit shop drawings indicating sizes, profiles, coursing, trims, bending and placement of reinforcing bars, and other special applications as specified in this Section.
  3. Samples for Verification: Submit samples for verification by Consultant for each type and colour of brick masonry veneer specified.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.



## 1.6 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 00 – Closeout Submittals; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

## 1.7 SITE CONDITIONS

1. Ambient Conditions: Install masonry setting materials and weathering membranes in accordance with weather protection requirements and within temperature limitations described in CAN/CSA A371.

# 2 Products

## 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Glen-Gery
  2. H.C. Muddox
  3. Hebron Brick.
  4. Interstate Brick.
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 MATERIALS

1. Brick Masonry Veneer: Burned clay brick manufactured in accordance with CAN/CSA A82.1, and as follows:
  1. Type and Grade: Type X, Exterior Grade (EG).
  2. Compressive Strength: Minimum 20 MPa.
  3. Size: Nominal 290 mm x 57 mm x 90 mm.
  4. Colour and Finish: Claret; Velour.
  5. Basis-of-Design Products: Brampton Brick, Contemporary Series, Metric Norman.
2. Special Shapes:
  1. Provide units without cores or frogs and with exposed surfaces finished for ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces.
  2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including at corners, movement joints, bond beams, sashes, and lintels.
  3. Provide special shapes for applications requiring brick of size, form, colour, and texture on exposed surfaces that cannot be produced by sawing.
  4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

## 2.3 ACCESSORIES

1. Mortar: Refer to Section 04 05 12 – Masonry Mortar and Grout.

2. Connectors, Ties, and Anchors: Refer to Section 04 05 19 – Masonry Anchorage and Reinforcement.
3. Embedded Flashing: Refer to Section 04 15 00 – Masonry Accessories.
4. Joint Sealants: Foam backing rod and sealant system as specified in Section 07 92 00 – Joint Sealants, and as follows:
  1. Sealant Type: Polyurethane, polysulphide, acrylic or silicone as selected by Subcontractor.
  2. Vertical Sealant: Colour to match brick masonry veneer.
  3. Horizontal Sealant: Colour to match mortar.
5. Movement Joint Filler: Refer to Section 04 15 00 – Masonry Accessories.
6. Masonry Veneer Supports: Refer to Section 04 05 19 – Masonry Anchorage and Reinforcement.
7. Cellular Plastic Weep/Vent Inserts: Refer to Section 04 15 00 – Masonry Accessories.
8. Cavity Drainage Material: Refer to Section 04 15 00 – Masonry Accessories.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

1. Install brick masonry veneer in accordance with CAN/CSA A371, as modified by manufacturer's written instructions to accommodate site installation requirements, and as follows:
  1. Thickness: Build cavity to full thickness as shown on Drawings.
  2. Unit Sizes: Use full size units without cutting except as follows:
    1. Cut units with motor driven saws if cutting is required to provide a continuous pattern or to fit adjoining construction.
    2. Provide clean, sharp, un-chipped edges.
    3. Install cut units with cut surfaces and cut edges concealed where possible.
    4. Obtain Consultant's acceptance where cut edges must be exposed.
  3. Aesthetic Consistency: Select and arrange units for brick masonry veneer to produce a uniform blend of colours and textures; mix units by drawing units diagonally down multiple rows from at least three different pallets as masonry units are placed.
2. Shelf Angle Supports: Refer to Section 04 05 19 – Masonry Anchorage and Reinforcement.
3. Masonry Coursing: Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement joints, returns, and offsets; avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
4. Bond Pattern for Brick Masonry Veneer: Lay brick masonry veneer as indicated on Drawings; do not use units with less than 100 mm horizontal face dimensions at corners or jambs.
5. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below, and as follows:
  1. Do not tooth or zipper work into successive work.
  2. Clean brick masonry veneer surfaces that are receiving mortar, remove loose masonry units and mortar.
6. Built-In Work: Build in items specified in this and other Sections as construction progresses.

7. Mortar Bedding and Jointing: Set brick masonry veneer units in full bed of mortar with full vertical joints, and as follows:
  1. Fill dowel, anchor, and similar holes.
  2. Clean soiled surfaces with fibre brush and soap powder and rinse thoroughly with clear water.
  3. Tool exposed joints when mortar is thumbprint hard, using a profile jointer tool, and as follows:
    1. Concave Profile: All exposed joints.
8. Cavity Connectors and Veneer Ties: Connect brick masonry veneer to substrate using connectors and ties specified in Section 04 05 19 – Masonry Anchorage and Reinforcement.
9. Flashing, Vents, Weeps, and Cavity Accessories: Refer to Section 04 15 00 – Masonry Accessories.
10. Cavity Air Barrier Membranes: Install air barrier membrane in accordance with Section 07 27 16 – Air Barrier Membrane; seal around items penetrating membrane with membrane manufacturer's recommended repair mastic.
11. Cavity Insulation: Install cavity wall insulation in accordance with Section 07 21 13 – Board Insulation, using insulation restraints forming a part of the veneer tie system, and as follows:
  1. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways.
  2. Fit insulation firmly against substrate.
  3. Fill cracks and open gaps in insulation with foamed-in-place insulation compatible with insulation and masonry.
  4. Adhere insulation to uneven substrate surfaces to eliminate air spaces between insulation and substrate.
12. Movement Joints: Install movement joint materials in brick masonry veneer as masonry progresses; do not allow materials to span movement joints without provision to allow for in-plane wall or partition movement, and as follows:
  1. Location of Control Joints: Refer to Drawings for movement joint locations, and as follows:
    1. Confirm location with Consultant before installation.
    2. Confirm with Consultant if control joints are not shown on Drawings.
  2. Composition: Form control joints in brick masonry veneer consisting of a complete vertical break free from mortar using one of the following methods:
    1. Break joint reinforcement at control joints but extend bond beam reinforcing 400 mm into wall across control joint and wrap with 0.15 mm polyethylene bond breaker.
    2. Install temporary foam plastic filler in head joints and remove filler when brick masonry veneer is complete for application of sealant.
    3. Remove joint filler when brick masonry veneer is complete and ready for application of joint sealant.
    4. Finish visible joints with rod and sealant in accordance with Section 07 92 00 – Joint Sealants.
  3. Vertical Movement Joints: Form movement joints in brick masonry consisting of a complete vertical break free from mortar using one of the following methods:
    1. Build flanges of metal expansion strips into masonry; lap each joint 100 mm in direction of water flow; seal joints below grade and at junctures with horizontal movement joints if any.
    2. Build flanges of factory fabricated, movement joint units into masonry.
    3. Fit compressible joint filler materials into head joints to prevent accumulation of mortar or debris.

4. Form open joint full depth of brick masonry veneer unit wythe a minimum of 10 mm for installation of sealant and backer rod specified in accordance with Section 07 92 00 – Joint Sealants.
  5. Locate joints at 6000 mm O/C maximum and at a minimum of 3600 mm from any corners, any other indication notwithstanding.
  6. Remove joint filler when brick masonry veneer is complete and ready for application of joint sealant.
  7. Finish visible joints with rod and sealant in accordance with Section 07 92 00 – Joint Sealants.
4. Horizontal Control Joints: Install a minimum 10 mm high horizontal, pressure relieving joints by inserting a compressible filler, sealant and backer rod specified in Section 07 92 00 – Joint Sealants; locate horizontal, pressure relieving joints beneath shelf angles supporting masonry.

### 3.3 CLOSEOUT ACTIVITIES

1. Adjusting: Remove and replace brick masonry veneer units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units and install new units in fresh mortar to eliminate evidence of replacement.
2. Cleaning: Clean brick masonry veneer as work progresses by dry brushing to remove mortar fins and smears before tooling joints after mortar is thoroughly set and cured, and as follows:
  1. Clean brick masonry veneer by cleaning methods indicated in BIA Technical Notes 20 and 23A.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section includes requirements for the delegated design, supply and installation of structural metal stud framing capable of resisting wind loads, building loads and movements in accordance with Section 01 35 73 – Delegated Design Procedures, and includes, but is not limited to, the following components:
  1. Studs subjected to lateral loads.
  2. Top and bottom tracks.
  3. Bridging and bracing.
  4. Top and bottom track connections to main structure, including fabrications to accommodate main structure deflections; top of wall anchor allowing for dead load deflections during construction and live load deflections after construction.
  5. Head, sill, and jamb members at wall openings.
  6. Framing component connections.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society of Mechanical Engineers International (ASME):
  1. ASME B18 Series Codes and Standards as referenced for specific screws, nuts, bolts, and other fasteners.
3. American Society for Testing and Materials (ASTM International):
  1. ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000PSI Tensile Strength
  2. ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
  3. ASTM A780/A780M-20, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
  4. ASTM A792/A792M-21a, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
  5. ASTM F3125/F3125M-21, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
4. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating
  2. CAN/CGSB 7.1-98, Lightweight Steel Wall Framing Components
5. Canadian Sheet Steel Building Institute (CSSBI):
  1. CSSBI 51-06, Lightweight Steel Framing Design Manual
  2. CSSBI S5-2019, Guide Specification for Wind Bearing Steel Studs
  3. CSSBI S6-2019, Guide Specification for Lightweight Steel Framing
6. Canadian Standards Association (CSA Group):
  1. CSA A370-14 (R2018), Connectors for Masonry
  2. CSA S16:19, Design of Steel Structures

3. CSA S136-16, North American Specification for the Design of Cold-Formed Steel Structural Members
4. CSA W47.1:19, Certification of Companies for Fusion Welding of Steel
5. CSA W59-18, Welded Steel Construction

#### 1.4 DEFINITIONS

1. Minimum Uncoated Steel Thickness: Minimum uncoated thickness of lightweight steel framing shall be not less than 95% of the thickness used in the design for the framing system:
2. Lesser thicknesses may be permitted at bends arising from the cold forming process.
3. Metal thicknesses listed in this section are minimum uncoated steel thickness, exclusive of any subsequent coatings or treatments.
4. Delegated Design Professional Engineer: The professional engineer hired or contracted to the fabricator or manufacturer to design specialty elements, produce delegated design submittals and shop drawings to meet the requirements of the Project; who is registered in the province of the Work; and who is not the Consultant.

#### 1.5 ADMINISTRATIVE REQUIREMENTS

1. Pre-Construction Meetings: Arrange for pre-construction meeting in accordance with Section 01 31 19 – Project Meetings with Contractor, Subcontractor, and Consultant to discuss installation requirements and site reviews required by the Consultant, the delegated design professional engineer, and as follows:
2. Provide minimum 72 hours notice to Consultant before starting work of this Section; increase notice period where time period spans weekends or statutory holidays.
3. Do not conceal wind load bearing steel stud framing system until reviewed by Consultant.

#### 1.6 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for mechanical fasteners, indicating sizes, shear, and pull-over loading capacity where applicable. Provide data indicating thickness and type of corrosion protection coating.
  2. Shop Drawings: Submit shop drawings clearly indicating all construction details including connections and anchor requirements. Indicate type, size and spacing of fastening devices. Indicate design loads; include seal and signature of a professional engineer registered in the Province of the Work for shop drawings requiring structural design.
3. Informational Submittals: Provide following submittals:
  1. Certificates: Submit evidence of welder qualifications meeting requirements for work being performed by this Section.
  2. Delegated Design Submittals: Provide delegated design in accordance with Section 01 35 73 – Delegated Design Procedures, for design criteria described in this Section, and as follows:
  3. Submit delegated design professional engineer's design notes and calculations when requested by the Consultant.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.7 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant:

1. Supplier: Use a manufacture capable of designing, fabricating, and erecting of work of this Section in accordance with applicable Building Code and Contract Documents and is capable of providing delegated design requirements for design, site review and certification of installation.
2. Installer: Use welders certified by the Canadian Welding Bureau in accordance with CSA W47.1 for the type of work being performed; perform welding in accordance with CSA W59.

### **1.8 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance: Deliver steel stud framing clearly marked with core steel thickness by embossing, stamping with indelible ink or by colour coding.
2. Storage and Handling: Store materials flat, blocked off ground in manner to prevent kinking or permanent set; bent, kinked, or twisted studs and track will be rejected.

## **2 Products**

### **2.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. ClarkDietrich
  2. DASS Metal Products
  3. DCM Metal Corp
  4. Steelform NLB Products
  5. Trebor Building Products Ltd.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### **2.2 PERFORMANCE REQUIREMENTS**

1. Perform design, fabrication, and erection of the work of this Section based on Limit States Design principles using factored loads and resistances, determined in accordance with CSA S136.
2. Conform to the requirements of indicated fire resistance ratings.
3. Design wall framing system capable of withstanding design loads within limits and under design loads indicated on Drawings, and as follows:
  1. Dead Loads: Weights of materials and construction.
  2. Wind Loads: Wind Loads: q50 for deflection and for strength, modified by the appropriate importance factor, exposure, gust effect factors, and pressure coefficients (internal and external) in accordance with commentary "I" of the National Building Code structural commentaries.
  3. Earthquake Loads: Refer to Structural Drawings.
  4. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 70°C.
  5. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure upward and downward movement of 19 mm or as otherwise indicated; provide larger gap as may be required to accommodate structural movement.

6. Design deflection detail so that free floating vertical members are restrained from horizontal movement by means of continuous bridging, nested or boxed tracks, or sliding or flexible web connections.
  7. Maximum allowable deflection under q50 sustained wind loading (with the appropriate importance factors for ULS and SLS shall be as follows:
    1. Behind concrete masonry veneer – stud deflection limited to  $L/720$ .
    2. Behind metal cladding or other finishes – stud deflection limited to  $L/360$ .
  8. Allow for movement of the structure; design lightweight steel framing end connections to accommodate floor and roof deflections such that studs are not loaded axially; limit free play and movement in connections perpendicular to the plane of framing to  $\pm 0.50$  mm relative to the building structure.
  9. Design connections between light steel framing members using bolts, welding, or sheet metal screws.
  10. Design bridging to prevent member rotation and member translation perpendicular to the minor axis, and as follows:
  11. Design for secondary stress effects due to torsion between lines of bridging.
  12. Collateral contribution of sheathing materials may be used to help restrain member rotation and translation perpendicular to the minor axis for wind bearing studs.
  13. Design bridging at 1530 mm centres maximum, closer spacing may be required by design to satisfy structural requirements; spaced at even intervals over the span of the member.
4. Stud, sill and top track sizes and thicknesses, and fastening details indicated in this Section and on the Drawings shall be considered as minimums only, spacing indicated as maximum permissible, except where changes are required to meet design criteria, and as follows:
1. Design head, sill and jamb members to frame openings larger than 100 mm in any dimension.
  2. Design components or assemblies to accommodate specified tolerances of the structure.
  3. Sill and Top Tracks:
    1. Double track system, outer track flanges with depth to suit vertical deflection and width of studs.
    2. Sill tracks, minimum 33 mm deep flanges and width of studs.
  4. Movement Connection Clips: Purpose made clip designed to allow structural member vertical movement and to transfer wind suction or pressure to structural frame.
  5. Maximum design spacing of stud members shall not exceed 406 mm centres in exterior partitions and 610 mm centres in interior partitions.
  6. Maximum spacing for top and bottom track connections to the structure shall not exceed 810 mm centres.
  7. Minimum design thickness for wall framing members shall be as follows or thicker when required to meet project performance requirements:
    1. 64 mm: 33 (0.84 mm).
    2. 92 mm: 33 (0.84 mm).
    3. 101 mm: 33 (0.84 mm).
    4. 140 mm: 33 (0.84 mm).
    5. 152 mm: 43 (1.09 mm).
    6. 184 mm: 54 (1.37 mm).
    7. 203 mm: 54 (1.37 mm).
    8. Minimum thickness for walls supporting masonry veneer shall be 54 (1.37 mm) regardless of minimum thickness indicated above, or thicker as required to suit design conditions.
  8. Bridging Channel: 1.09 mm minimum.
  9. Clip Angles: 1.37 mm minimum.



## 2.3 MATERIALS

1. Steel Stud Framing Members and Accessories: Provide lateral loadbearing steel stud framing members manufactured in accordance with CSSBI 58, and as follows:
  1. Steel conforming to CSA S136 and shall be identified as to specification, type grade and mechanical properties; metal core thickness and spacing determined by delegated design professional engineer, hot dipped galvanized steel; roll formed with knurled flanges, and cut-outs for services and bracing
  2. Galvanizing conforming to ASTM A653/A653M to a minimum of Z275 for masonry veneer assemblies and Z180 for other exterior wall assemblies; the Consultant may accept other coatings meeting or exceeding the corrosion protection listed upon written request to the Consultant.
  3. Colour Coding: In accordance with Lightweight Steel Framing Manual, published by Canadian Sheet Steel Building Institute.
2. Fasteners and Welds: Provide fasteners and welding materials in accordance with CSSBI 58, and as follows:
  1. Welding Electrodes: Welding materials conforming to CSA W59; electrodes minimum 480 MPa tensile strength.
  2. Fasteners: Bolts and nuts conforming to ASTM A307 or ASTM F3125, with washers and hot-dip galvanized finish.
  3. Metal-to-Metal: Sheet metal screws conforming to ASME 18, with galvanized coating; self-drilling, self-threading, case hardened type; hex, pan, and low-profile head profile type to suit application; length sufficient to penetrate not less than 3 fully exposed threads beyond joined materials.
  4. Metal-to-Concrete: Drilled stainless steel screw anchor; do not use powder actuated fasteners unless accepted in writing by Consultant:
    1. Basis-of-Design Products: Hilti Kwik Con
  5. Metal-to-Structural Steel: Secure track to structural steel over 8 mm thickness with proprietary fastening system:
    1. Basis-of-Design Products: Hilti DX Fastening System with ENP2-21L15MX.
  6. Drilled Inserts: Steel, cadmium plated, or hot dip galvanized, sizes as indicated on drawings.

## 2.4 ACCESSORIES

1. Touch Up Paint: Zinc rich for touching up welds and damaged metallic coating meeting requirements of ASTM A780.
2. Sill Gaskets: Flexible, self-adhering closed cell foam membrane that bridges gaps and irregularities between top of concrete foundation and sill components; nominal 10 mm thickness x to suit width of studs x manufacturer's maximum length, and as follows:
  1. Basis-of-Design Products: ProtectoWrap, Triple Guard Energy Sill Sealer.
3. Levelling Grout: Pre-mixed non-metallic, non-shrink, non-corrosive, non-staining Portland cement-based grout meeting requirements of ASTM C1107, Grade A, B and C, having minimum compressive strength of 34.5 MPa.
4. Shims: Load bearing, high-density, non-leaching multi-monomer plastic; or cold-formed steel of same grade and coating as framing members supported by shims.
5. Thermal Insulation: Refer to Section 07 21 13 – Board Insulation.

## 2.5 SOURCE QUALITY CONTROL

1. Mill Reports: Consultant will request submission of mill test certificates for SSF Products that originate outside of Canada or the United States:

1. Onshore Testing Verification: Submit copies of purchase orders or receipts indicating source of supply from Canada or the United States.
2. Offshore Testing Verification: Verify mill test certifications through a Canadian laboratory; laboratories must be accredited by the Standards Council of Canada and comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate.
3. Testing Identification: Label mill test certificates with the name of the Canadian laboratory and appropriate wording stating that the material is in conformance with the requirements specified in the Contract Documents; include the appropriate material designation, testing date, and signature of an authorized officer of the Canadian laboratory in the stamp.

### 3 Execution

#### 3.1 PREPARATION

1. Confirm that flashings and waterproof membranes provided by other Sections are properly installed to divert moisture to exterior.
2. Confirm that door and window frames are placed and securely braced in proper location.

#### 3.2 ERECTION

1. Fabrication and erection shall conform to the reviewed shop drawings; modifications required to accommodate on-site conditions, other than minor dimensional changes, shall be resubmitted by the delegated design professional engineer and reviewed with the Consultant for acceptance prior to proceeding with work.
2. Provide continuous top and bottom tracks.
3. Align exterior wall partition tracks at floor and underside of deck, isolate track from direct contact with concrete using moisture barrier.
4. Cut bottom of metal studs square and set with full contact in bottom track; screw-fasten both flanges to sill track.
5. Place studs vertically at not more than 50 mm from abutting walls, and at each side of openings and corners; position studs in tracks at floor and ceiling, unless noted otherwise.
6. Cross-brace steel studs as required to provide rigid installation to delegated design engineer instructions; attach studs to lower ceiling track using specified fasteners.
7. Cut members using saw or shear; flame cutting is not permitted.
8. Provide minimum of three studs at corners; insulate exterior components not accessible from interior using mineral fibre insulation:
  1. Place insulation equal to that specified for the field area of assemblies into non-accessible areas such as jamb and header assemblies, corners, and wall to roof transitions.
  2. Keep insulation dry after installation. Do not compress insulation.
9. Provide cross studs secured to studs, and additional framing as required for support of fixtures mounted to walls.
10. Erection tolerances shall be as follows:
  1. Erect steel studding to tolerance of  $\pm 3$  mm, non-cumulative from design spacing. Spacing in any case shall not exceed the requirements of the finishing materials.
  2. Out-of-plumb shall not exceed 1/500 of the member length.
  3. Out-of-straight (camber or sweep) shall not exceed 1/1000 of the member length.
  4. Track camber shall not exceed 1/1000 of member length.
  5. Studs shall seat into top and bottom tracks; gap between the end of the stud and the web of the track shall not exceed 4 mm for lightweight steel framing.
  6. Distance from centreline of last un-reinforced cut-out to end of framing member shall not be less than 305 mm.

11. Coordinate simultaneous erection of studs with installation of service lines; align web openings when erecting studs.
12. Coordinate erection of studs with installation of door/window frames and special supports or anchors for Work specified in other Sections.
13. Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together using sheet metal and screw fasteners.
14. Erect track at head of door openings and sills of sidelight/window openings to accommodate intermediate studs; secure track to studs at each end; install intermediate studs above and below openings in same manner and spacing as wall studs.
15. Install steel studs or furring channel between studs for attaching electrical and other boxes.
16. Perform welding in accordance with CSA W59; for material less than 3 mm thick, the effective throats of welds shall not be less than the thickness of the thinnest connect part:
  1. Mechanically fasten all members having a thickness of 0.91 mm and less; weld or mechanically fasten members having thicknesses of 1.12 mm and greater
17. After erection, refinish damaged finishes, welds, fastener heads and nuts with zinc rich paint, in accordance with paint manufacturer's instructions.

### **3.3 FIXTURE ATTACHMENT AND ACCESS PANELS**

1. Install all attachments within steel-stud partitions for fixtures being hung from or anchored to such partitions.
2. Install access doors to electrical or mechanical fixtures supplied under respective Sections.
3. Rigidly secure frames to furring or framing systems.

### **3.4 INSPECTION AND CERTIFICATION**

1. The installation of the exterior steel stud walls shall be inspected periodically by the delegated design professional engineer responsible for the component selection and connection designs for conformance to the shop drawings and design intent in accordance with Section 01 35 73 – Delegated Design Procedures.
2. Forward copies of inspection reports to Owner, Consultant, and the Subcontractor responsible for the Work and the Contractor.
3. Prior to declaration of Substantial Performance, delegated design professional engineer shall submit a Letter of Compliance, signed, and sealed in accordance with Section 01 35 73 – Delegated Design Procedures.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements for supply and installation of non-ornamental metal fabrications and miscellaneous metals required for installation of other metal and structural components.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing Materials (ASTM International):
  1. ASTM A27/A27M-20, Standard Specification for Steel Castings, Carbon, for General Application
  2. ASTM A47/A47M-99(2018)e1, Standard Specification for Ferritic Malleable Iron Castings
  3. ASTM A36/A36M-19, Standard Specification for Carbon Structural Steel
  4. ASTM A53/A53M-20, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
  5. ASTM A108-18, Standard Specification for Steel Bar, Carbon, and Alloy, Cold-Finished
  6. ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  7. ASTM A153/A153M-16a, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  8. ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod 60,000 PSI Tensile Strength
  9. ASTM A653/A653M-20, Standard Specification For Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) By The Hot Dip Process
  10. ASTM A666-15, Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar
  11. ASTM A780/A780M-20, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
  12. ASTM A786/A786M-15, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
  13. ASTM A792/A792M-21a, Specification for Steel Sheet, 55% Aluminum-Zinc Alloy Coated by the Hot Dip Process
  14. ASTM B221-20, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  15. ASTM D1187/D1187M-97(2018), Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
  16. ASTM E488/E488M-18, Standard Test Methods for Strength of Anchors in Concrete Elements
  17. ASTM F568M-07, Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners
  18. ASTM F1554-20, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-Ksi Yield Strength
  19. ASTM F3125/F3125M-19e2, 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

3. Canadian Standards Association (CSA Group):
  1. CSA S16:19, Design of Steel Structures, Includes Errata (2019)
  2. CSA G30.18-09 (R2019), Carbon Steel Bars for Concrete Reinforcement, Includes Update No. 1 (2012)
  3. CSA-G40.20-13/G40.21-13 (R2018), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
  4. CSA W47.1:19, Certification of Companies for Fusion Welding of Steel
  5. CSA W55.3-08 (R2018), Certification of Companies for Resistance Welding of Steel and Aluminum
  6. CSA W59-18, Welded Steel Construction, Includes Errata (2020)
  7. CSA W178.1-18, Certification of Welding Inspection Organizations
4. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 1.40M-97, Primer, Structural Steel, Oil Alkyd Type
  2. CAN/CGSB 1.181M-99, Ready-Mixed Organic Zinc-Rich Coating
5. The National Association of Architectural Metal Manufacturers (NAAMM):
  1. NAAMM AMP 555-92, Code of Standard Practice for Architectural Metal Industry (Including Miscellaneous Iron)

#### 1.4 ADMINISTRATIVE REQUIREMENTS

1. Coordination: Coordinate with for requirements affecting this Section and as follows:
  1. Anchorages: Provide setting drawings, templates, and directions for installing anchorages including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are embedded in concrete or masonry and deliver to site in time for installation.
  2. Priming and Galvanizing: Coordinate priming and galvanizing requirements for non-architecturally finished components.
  3. Architectural Finishing: Coordinate finishing requirements with paint systems specified in Section 09 91 00 – Painting; failure to apply referenced primer will result in this section removing applied primer and recoating with specified material at no additional cost to Owner or Consultant.

#### 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for the following:
    1. Non-slip aggregates and non-slip aggregate surface finishes.
    2. Grout.
    3. Fasteners.
    4. Prefabricated components.
    5. Paint and coating products.
  2. Shop Drawings: Submit shop drawings indicating detailed fabrication and erection of each metal fabrication indicated in accordance with NAAMM AMP 555 including but not limited to plans, elevations, sections, and details of metal fabrications and connections; show anchorage and accessory items.
3. Informational Submittals: Provide the following submittals when requested by the Consultant:
  1. Certificates: Submit certificates for the following:
    1. Mill certificates signed by manufacturers of stainless-steel sheet certifying that products provided are in accordance with requirements of this Section.
    2. Copies of welding certificates for welding procedures and personnel.

2. Qualification Statement: Submit qualification data of fabricator and employed personnel indicating their capabilities and experience; include lists of completed projects with project names and addresses, names, and addresses of architects and owners, and other information specified when requested by the Consultant.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.6 QUALITY ASSURANCE

1. Regulatory Requirements: Perform structural welding, use personnel, and qualify procedures.
2. Qualifications: Provide proof of qualifications when requested by the Consultant:
  1. Fabricators: Use fabricator experienced in producing metal fabrications similar to those required for this project and with a record of successful in-service performance with sufficient production capacity to produce required units.
  2. Personnel: Use welders qualified by Canadian Welding Bureau for classification of work being performed that are experienced in type and extent of work required for the project.

## 1.7 SITE CONDITIONS

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where metal fabrications are indicated to fit walls and other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Established Dimensions: Establish dimensions and proceed with fabricating metal fabrications without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.

## 2 Products

### 2.1 MATERIALS

1. Metal Surfaces: Provide materials with smooth, flat surfaces without blemishes for metal fabrications exposed to view in the completed Work; do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
2. Ferrous Metals:
  1. Steel Plates, Shapes, and Bars: In accordance with CAN/CSA G40.20/G40.21, Grade 300W or ASTM A36/A36M.
  2. Hollow Structural Sections: In accordance with CAN/CSA G40.20/G40.21, Grade 350W, Class C or ASTM A500 Grade C.
  3. Stainless Steel Sheet, Strip, Plate, and Flat Bars: In accordance with ASTM A666, Type 304.
  4. Stainless Steel Bars and Shapes: In accordance with ASTM A276, Type 304.
  5. Rolled Steel Floor Plate: In accordance with ASTM A786/A786M, rolled from plate meeting requirements for ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
  6. Rolled Stainless Steel Floor Plate: In accordance with ASTM A793.
  7. Steel Tubing: Cold formed steel tubing in accordance with ASTM A500.
  8. Steel Pipe: In accordance with ASTM A53, standard weight (Schedule 40).
  9. Welding Rods and Bare Electrodes: Select according to CWB specifications for metal alloy welded.
3. Non-Ferrous Metals:
  1. Aluminum Extrusions: In accordance with ASTM B221, alloy 6063-T6.
  2. Aluminum Alloy Rolled Tread Plate: In accordance with ASTM B632/B632M, alloy 6061-T6.

4. Cementitious Materials:
  1. Grout: Non-Shrink, Non-Metallic Grout: Factory packaged, non-staining, non-corrosive, non-gaseous grout in accordance with ASTM C1107, specifically recommended by manufacturer for interior applications.
  2. Concrete: Provide concrete meeting requirements of Division 03 – Concrete and Structural Drawings for normal weight, air entrained, ready-mix concrete having a minimum 28-day compressive strength of 20 MPa.
5. General Fasteners: Provide Type 304 or 316 stainless steel fasteners for exterior and zinc plated fasteners with coating in accordance with ASTM B633, Class Fe/Zn 5, where built into exterior walls; select fasteners for type, grade and class required and selected from the following:
  1. Bolts and Nuts:
    1. Bolts: Regular hexagon head bolts, ASTM A307, Grade A or ASTM F568M, Property Class 4
    2. Nuts and Washers ASTM A563/A563M hex nuts and flat washers.
  2. Anchor Bolts: ASTM F1554, Grade 36.
  3. Machine Screws: ASME B18.6.3/B18.6.7M.
  4. Lag Bolts: ASME B18.2.1/B18.2.3.8M.
  5. Wood Screws: Flat head, carbon steel, ASME B18.6.1.
  6. Plain Washers: Round, carbon steel, ASME B18.22.1/B18.22M.
  7. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1/B18.21.2M.
6. Premanufactured Fasteners:
  1. Site Installed Headed Stud Shear Connectors: Steel in accordance with ASTM A108, Grades 1010 through 1020 or CSA W59, Appendix H, headed stud type, cold finished carbon steel, with arc shields, size as indicated on drawings:
    1. Minimum Tensile Stress: 414 MPa.
    2. Minimum Yield Stress: 345 MPa.
    3. Minimum Elongation: 50 mm 20%.
    4. Acceptable Products:
      1. Nelson Stud Welding.
      2. Erico International Corporation.
      3. Other acceptable product manufacturer.
  2. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency and as follows:
    1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, hot dip galvanized in accordance with ASTM A153/A153M.
  3. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency and as follows:
    1. Carbon steel components zinc plated in accordance with ASTM B633, Class Fe/Zn 5
    2. Alloy Group 1 or 2 stainless steel bolts in accordance with ASTM F593 and ASTM F738M and nuts in accordance with ASTM F594 and ASTM F836M.

4. Quarter Turn Cam Lock Fasteners: Stainless steel; 90° quick release; 10 mm diameter; non-ejecting fastener with folding bail handle, stainless steel retainer and reinforced mounting tabs providing detent in closed position, and as follows:
  1. Acceptable Products: DFCI Solutions Inc., ST-1200 Series.
7. Finishes: Finish metal fabrications in accordance with NAAMM Metal Finishes Manual for Architectural and Metal Products following recommendations for applying and designating finish after assembly and as follows:
  1. Steel and Iron Finishes:
    1. Galvanizing: Hot dip galvanize items as indicated in accordance with applicable standard following:
      1. Products: To ASTM A123/A123M.
      2. Hardware: To ASTM A153/A153M.
    2. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces in accordance with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
      1. Interiors: SSPC Zone 1A: SSPC-SP3.
  2. Stainless Steel Finishes: Remove tool and die marks and stretch lines or blend into finish; grind and polish surfaces to match original finish; passivate and rinse surfaces after polishing, remove embedded foreign matter and leave surfaces chemically clean.
  3. Aluminum Finishes: As-Fabricated Finish, AA-M10, mill finish.
  4. Applied Finishes: Apply finishes to uncoated surfaces of metal fabrications, except items with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry in accordance with SSPC-PA1, Paint Application Specification No. 1; stripe coat corners, crevices, bolts, welds, and sharp edges, and as follows:
    1. Shop Primers: Provide primers that are compatible with paint systems specified in Section 09 91 00 – Painting.
    2. Galvanizing Repair Paint: High zinc dust content paint for re-galvanizing welds in steel, in accordance with SSPC-Paint 20.
    3. Bituminous Paint: Cold applied asphalt mastic in accordance with SSPC-Paint 12; except containing no asbestos fibres, or cold applied asphalt emulsion in accordance with ASTM D1187/D1187M.

## 2.2 FABRICATION

1. Shop Fabrication: Shear and punch metals cleanly and accurately, remove burrs; ease exposed edges to a radius of approximately 1 mm; form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work and as follows:
  1. Fabricate joints exposed to weather to exclude water or provide weep holes where water may accumulate.
  2. Fabricate assemblies exposed to exterior conditions that allow for thermal movement resulting from ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects.
  3. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
  4. Remove sharp or rough areas on exposed traffic surfaces.
2. Shop Welding: Weld corners and seams continuously and as follows:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.



4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
3. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize site splicing and assembly and as follows:
  1. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
  2. Use exposed fasteners of type indicated; or if not indicated, Phillips flat-head countersunk screws or bolts.
  3. Locate joints where least conspicuous.
  4. Disassemble units only as necessary for shipping and handling limitations.
  5. Use connections that maintain structural value of joined pieces.
  6. Clearly mark units for reassembly and coordinated installation.
4. Anchorage Fabrication: Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support required loads; provide for anchorage of type indicated and suitable for supporting structure, and as follows:
  1. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

### 3 Execution

#### 3.1 INSTALLATION

1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
2. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels and as follows:
  1. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
  2. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
3. Site Welding: Perform welding work in accordance with CSA W59; do not weld, cut, or abrade surfaces of exterior units that have been hot dip galvanized after fabrication and are for bolted or screwed site connections and as follows:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
4. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with bituminous paint applied to a high build thickness of 1.5 to 2 mm.

### 3.2 CLOSEOUT REQUIREMENTS

1. Adjusting: Touch-Up of Shop Applied Primer: Immediately after erection, clean site welds, bolted connections, and abraded areas of shop coatings, and recoat exposed areas using same material as used for shop priming in accordance with SSPC-PA1 for touching up shop coated surfaces; apply by brush or spray to a minimum 0.05 mm dry film thickness.
2. Cleaning: Galvanized Surfaces: Clean site welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

### 3.3 COMPONENT SCHEDULE

1. The following listing of metal fabrications is provided by the Consultant for the convenience of the Contractor every attempt has been made to provide a complete list of metal fabrications; however, it and is not intended to be comprehensive listing, which is the Contractor's responsibility; list of metal fabrications includes but is not limited to, the following:
  1. Miscellaneous Framing and Supports: Structural steel shapes, plates, and bars of welded construction; galvanized in exterior construction; fabricated to sizes, shapes, and profiles necessary to receive adjacent construction retained by framing and supports; cut, drill, and tap units to receive hardware, hangers, and similar items including but not limited to the following:
    1. Steel framing and supports for countertops.
    2. Steel framing and supports for mechanical and electrical equipment.
    3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
  2. Access Ladders:
    1. Construct access ladders in accordance with Ontario OH&S safety codes.
    2. Side Rails: Nominal 65 mm x 10 mm at 450 mm O/C, extend side rails to 1200 mm above upper surface, loop and return side rails for roof access ladders.
    3. Rungs: Nominal 21 mm diameter rungs shouldered and welded at 300 mm O/C maximum, rungs starting at 300 mm maximum above lower entry level or roof surface, finished with acceptable non-slip tread surface.
    4. Ladder Mounts: Nominal 65 mm x 10 mm brackets at maximum spacing of 3050 mm with support at the top of the side rails, and centreline of rungs at 150 mm from the wall face.
    5. Landing Platform: Non-slip grating tread.
    6. Usage Classification: Service.
    7. Quality of Finish: Prime ready for alkyd paint specified in Section 09 91 00 – Painting.
  3. Handrails: Provide handrails and brackets of the minimum diameter, standard weight pipe required to resist design loads, outer diameter 42 mm unless otherwise indicated on the drawings, and as follows:
    1. Return ends of metal wall handrails toward wall with radius corner and stop handrail 13 mm from wall with flat end.
    2. Space wall support brackets at a maximum of 1200 mm and not more than 300 mm from the ends.
    3. Design railings, and supports, in accordance with loads specified in the Building Code.
    4. Usage Classification: Commercial.
    5. Quality of Finish: Prime ready for alkyd paint specified in Section 09 91 00 – Painting.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for the supply and installation of dimensional lumber for miscellaneous use including, but not limited to, blocking, sheathing, and plywood backing panels.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society of Mechanical Engineers (ASME):
  1. ASME B18.6.1-1981 (R2016), Wood Screws (Inch Series)
3. American Society for Testing and Materials (ASTM International):
  1. ASTM A307-21, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
  2. 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
  3. ASTM F1667/F1667M-21a, Standard Specification for Driven Fasteners: Nails, Spikes and Staples
4. Canadian Standards Association (CSA Group):
  1. CSA O121-17 (R2022), Douglas Fir Plywood
  2. CSA O141:23, Canadian Standard Lumber
  3. CSA O151-17 (R2022), Canadian Softwood Plywood
  4. CSA O325:21, Construction Sheathing (Adopted NIST PS 2-18, with Canadian deviations)
  5. CSA O437 Series 93 (R2011), Standards on OSB and Waferboard
  6. CSA T530-99, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A)
5. National Lumber Grading Authority (NLGA):
  1. 2022 Standard Grading Rules for Canadian Lumber
6. Telecommunications Industry Association (TIA):
  1. TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's instructions, product literature and data sheets for wood products and accessories and include product characteristics, performance criteria, physical size, finish, and limitations.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.5 QUALITY ASSURANCE

1. Regulatory Requirements: Wood products used for sheathing and framing must be legibly identified on the face or edge indicating manufacturer of material, standard to which it was produced, grade of material including whether grade is visually graded, or machine stress rated, and exterior use where applicable in accordance with listed reference standards.

## 1.6 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Protect materials from weather conditions while in transit and while on the jobsite.
2. Storage and Handling Requirements: Store materials using pallets or blocking a minimum of 150 mm from the ground and covered with protective waterproof sheets allowing for air circulation and ventilation under the covering, and as follows:
  1. Protect edges and corners of sheet materials from damage during handling and storage.
  2. Protect kiln-dried and seasoned wood materials from conditions that will cause an increase to moisture content.

## 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

1. Lumber Grades: Provide lumber products that are all sides finished (S4S) in nominal dimensions required for the project; grade-marked by accredited agencies of the Canadian Lumber Standards Accreditation Board and conform to National Grading Rules published by the National Lumber Grades Authority, and as follows:
  1. Grading: Machine Grading, Visual Grading, or Both.
  2. Moisture Content: Kiln Dry, 19% or less.
  3. Structural Design Properties: Strength and related properties in accordance with CSA O86.
  4. Sizes: Nominal dressed dimensions described in CSA O141 for surfaced dry conditions and wood species.
2. Panel Grades: Provide panel products that are grade-marked by agencies recognized by CSA O325 and National Institute of Standards and Technology, Voluntary Product Standard PS 2-04 Performance Standard for Wood-Based Structural-Use Panels as modified by other listed CSA panel standards.
3. Volatile Organic Compound Emissions: Use adhesives in composite lumber and panel products that have no added urea-formaldehyde and that are not volatile at normal occupied building temperature conditions.

### 2.2 MATERIALS

1. Light Framing: Provide Construction Grade or Better, and having the following minimum properties:
  1. Sizes: 38 mm maximum width by depth to suit.
  2. Finger Jointed Materials: Not Allowed.
  3. Species Group: Spruce-Pine-Fir (SPF) or Douglas Fir (DF).
2. Miscellaneous Framing: Construction Grade or Better, and having the following minimum properties:
  1. Sizes: 38 mm maximum width by depth to suit.
  2. Finger Jointed Materials: Not Allowed.
  3. Species Group: Spruce-Pine-Fir (SPF).
3. Plywood Blocking and Backing Panels: Douglas Fir and Canadian softwood plywood using exterior grade adhesives meeting requirements of CSA O121 or CSA O151; kiln dry plywood to moisture content of 15% or less, and as follows:

1. Concealed Blocking: Select Grade (SEL) Canadian Softwood Plywood).
2. Exposed Panels and Panel Boards: Good One Side (G1S) Douglas Fir Plywood.
4. Sheathing: Provide plywood sheathing or oriented strand board at choice of Contractor, thickness as required by span rating and meeting requirements of CSA O325 and as follows:
  1. Plywood: Exterior Rated, Sheathing Grade square edged Douglas Fir or Canadian Softwood plywood meeting requirements of CSA O121 or CSA O151.
  2. Span Rated OSB: Exterior Rated, Sheathing Grade, oriented strand board or wafer board meeting requirements of CSA O437 SR 32/16.

### 2.3 ACCESSORIES

1. Driven Fasteners: Steel nails, spikes, brads, and staples meeting requirements of ASTM F1667/F1667M, length to penetrate connecting solid wood materials and as follows:
  1. Interior High Humidity Work: Hot dipped galvanized.
  2. Interior Work: Electroplated zinc plated, or cadmium plated.
2. Rough Hardware (Bolts, Nuts and Washers): Provide manufacturer's recommended fastening devices and anchors meeting the requirements of ASTM A307, and as follows:
  1. Interior High Humidity Work: Hot dipped galvanized.
  2. Interior Work: Electroplated zinc plated, or cadmium plated.
3. Wood Screws: Steel screws meeting requirements of ASME B18.6.1, and as follows:
  1. Interior Work: Galvanized.
4. Screws for Fastening to Cold Formed Metal Framing: Steel screws meeting requirements of ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

## 3 EXECUTION

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

1. Blocking, Furring and Grounds: Set miscellaneous rough carpentry to required levels and lines with members plumb, true to line, cut, and fitted; fit miscellaneous rough carpentry to other construction; scribe and cope as needed for accurate fit; locate furring, nailers, blocking, grounds, and similar supports as required attaching to other construction.
2. Backing in Metal Stud Assemblies: Install 19 mm CSP G1S plywood between metal stud assemblies on all walls receiving wall mounted equipment; minimum 2 stud spaces or 1220 mm wide x 1200 mm long panels; coordinate installation and locations with Drawings, and as follows:
  1. Fit plywood between metal studs. Kerf front of plywood panels to fit plywood face flush with front face of metal studs.
3. Telecommunications and Data Panel Boards: Install 19 mm DFP G1S plywood on all walls in telephone and data rooms receiving wiring and equipment; minimum 1220 mm x 2440 mm panels on periphery walls over 300 mm wide, mounted 150 mm off finished floor; coordinate installation and locations with Division 26 – Electrical, and as follows:

1. Paint panels with two (2) coats of light-coloured fire-retardant paint finish as specified in Section 09 91 00 – Painting; coat all sides of panels (back, front and sides) to meet the intent of fire-resistance rated panel requirements listed in CSA T530 and ANSI/TIA/EIA 569-B standard requirements.

### 3.3 CLOSEOUT REQUIREMENTS

1. Repairing: Repair damage to adjacent materials caused by rough carpentry installation.
2. Cleaning:
  1. Progress Cleaning: Clean in accordance with Section 01 74 13 – Progress Cleaning.
  2. Final Cleaning: Upon completion, remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 23 – Final Cleaning.
3. Protecting: Protect installed products and components from damage during construction.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of exterior grade gypsum sheathing panels for walls and soffits.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM C11-23, Standard Terminology Relating to Gypsum and Related Building Materials and Systems
  2. ASTM C954-22, Standard Specification for Steel Drill Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.75 mm) to 0.112 in. (2.84 mm) in Thickness
  3. ASTM C1177/C1177M-24, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
  4. ASTM C1280-18(2023), Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing
3. Canadian Construction Association (CCA):
  1. Standard Construction Document CCA 82-2004, Mould Guidelines for Canadian Construction Industry
4. Gypsum Association (GA):
  1. GA-253-2021, Application of Gypsum Sheathing
  2. GA-254-2017, Fire-Resistant Gypsum Sheathing
5. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

### **1.4 DEFINITIONS**

1. Refer to ASTM C11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Coordination with Air and Vapour Membranes: Coordinate with air and vapour membrane manufacturer and verify compatibility of exterior gypsum sheathing materials with membrane primers.

### **1.6 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's descriptive literature and brochures indicating compliance with specified requirements and providing detailed installation instructions.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.7 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
2. Storage and Handling Requirements: Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes; Stack gypsum sheathing panels flat and on sufficient spacers to prevent sagging, not in direct contact with floor surfaces.

## 1.8 SITE CONDITIONS

1. Ambient Conditions: Store and install materials specified in this Section in accordance with requirements of GA-253.
2. Protect gypsum sheathing board products from conditions that have the probability of causing mould growth during transportation and delivery, storage and handling, and installation in accordance with the Canadian Construction Association Mould Guidelines for the Canadian Construction Industry.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. CertainTeed Building Material Company.
  2. CGC Inc.
  3. Georgia Pacific Manufacturing Company.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 MATERIALS

1. Exterior Sheathing: Fibreglass matt faced gypsum based sheathing panels meeting requirements of ASTM C1177/C1177M, formulated specifically for exterior use in water managed building envelope systems in maximum lengths and widths practical to minimize joints in each area and to correspond with support system; and as follows:
  1. Thickness: As Indicated on Drawings
  2. Location: Exterior walls and soffits.
2. Fasteners: Corrosion resistant, ceramic-silicone resin coated self-drilling screws and as follows:
  1. For steel framing less than 0.835 mm thick, attach sheathing with steel drill screws complying with ASTM C1002.
  2. For steel framing from 0.84 to 2.84 mm thick, attach sheathing with drill screws complying with ASTM C954.
3. Sealant: Manufacturer's recommended silicone emulsion sealant; Meeting ASTM C920, Type S, Grade NS, compatible with accessories and for covering exposed fasteners. silicone sealant.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.



2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

1. Air and Vapour Membrane:
  1. Coordinate with self-adhered air and vapour membrane manufacturer and verify compatibility with membrane and primers with selected exterior gypsum-based sheathing.
  2. Install specified materials in accordance with material manufacturer's written instructions.

### 3.3 INSTALLATION

1. Install vertical and horizontal gypsum sheathing panels in accordance with ASTM C1280, GA-253, GA-254, and manufacturer's written instructions.
2. Install gypsum sheathing panels with face side out; butt panels together for a light contact at edges and ends with not more than 1.5 mm of open space between panels; do not force into place; locate edge and end joints over supports.
3. Attach gypsum sheathing panels to framing provided at openings and cut outs.
4. Form expansion joints to account for building movements using back-to-back framing members and edge trims, and a break in gypsum sheathing panel over structural movement joints and floor slab control joints as follows:
  1. Install expansion joints incorporating continuous air and vapour membranes and with sufficient gap to allow for projected building movements.
  2. Form expansion joints to meet fire ratings required for remainder of wall or soffit construction.
5. Space fasteners in gypsum sheathing panels according to referenced gypsum board application and finishing standards and manufacturer's written recommendations, and as follows:
  1. Space screws a maximum of 300 mm o/c for vertical applications.
  2. Space fasteners in panels that are tile substrates a maximum of 200 mm o/c.
6. Apply exterior soffit gypsum sheathing board perpendicular to supports, with end joints staggered and located over supports, and as follows:
  1. Install with 6 mm open space where panels abut other construction or structural penetrations.
  2. Fasten with corrosion resistant screws.

### 3.4 CLOSEOUT ACTIVITIES

1. Protecting: Protect installed products and components from damage during construction. Repair damaged to adjacent material caused by installation of materials specified in this Section.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply, fabrication, factory finishing and delivery to the job site, and installation of shop manufactured casework indicated on the drawings including, but not limited to, the following:
  1. Decorative laminate finished casework and cabinets.
  2. Hardware forming a part of casework and cabinets fabricated by this Section.
  3. Decorative laminate finished countertops.
  4. Solid surfacing material countertops.
  5. Shelving.
  6. Shop finishing of casework, cabinets, and countertops.
  7. Structural supports incorporated into casework.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American National Standards Institute (ANSI):
  1. ANSI A208.2-2009, Medium Density Fiberboard (MDF)
3. American Society for Testing and Materials (ASTM International):
  1. ASTM D1037-12(2020), Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
4. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 19.13-M87, Sealing Compound, One Component, Elastomeric, Chemical Curing
5. Canadian Standards Association (CSA Group):
  1. CSA O121-17, Douglas Fir Plywood
  2. CSA O141-05 (R2019), Softwood Lumber
  3. CSA O151-17, Canadian Softwood Plywood
6. National Electrical Manufacturers Association (NEMA):
  1. ANSI/NEMA LD 3-2005, High-Pressure Decorative Laminates (HPDL)
7. North American Architectural Woodwork Standards (NAAWS) 4.0.

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Architectural woodwork Subcontractor and the Contractor are jointly responsible for the following items:
  1. Coordinate delivery of casework components at a time when building and storage areas are sufficiently dry so that the casework will not be damaged by excessive changes in moisture content.
  2. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that interior casework can be supported and installed including, but not limited to, the following:
    1. Metal support brackets and fittings that are part of building structure.
    2. Plumbing, electrical fixtures and telephone equipment

## 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product indicated including, but not limited to, the following:
    1. Cabinet hardware and accessories.
    2. Finishing materials and processes.
    3. Manufactured medium density fibreboard.
    4. High pressure decorative laminate and adhesive for bonding decorative laminate.
    5. Low pressure decorative laminate.
    6. Solid surfacing materials.
  2. Shop Drawings: Submit shop drawings indicating location of each item referenced to actual site dimensions, dimensioned plans and elevations, large scale details and thickness of materials, attachment devices, scribe strip locations, locations of exposed fastenings and other components as applicable to the work of this Section and as follows:
    1. Show details full size.
    2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
    3. Show locations and sizes of cut outs and holes for plumbing fixtures, faucets, and other items installed in casework.
    4. Submittals prior to fabrication; do not fabricate any work until required submittals are reviewed and accepted by the Consultant.
  3. Samples for Verification: Submit two (2) samples prior to fabrication of casework as follows; accepted samples will form the standard of acceptance for the remainder of the work:
    1. High Pressure Decorative Laminate Clad Panel Products:
      1. Laid-up on specified core material, 300 mm x 300 mm for each type, colour, pattern, and surface finish.
    2. Low Pressure Decorative Overlay (Melamine) Surfaced Panel Products:
      1. Laid-up on specified core material, 300 mm x 300 mm for each type, colour, pattern, and surface finish.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.6 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Closeout Submittals; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

## 1.7 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Project Quality Standard: North American Architectural Woodwork Standards (NAAWS) published by the Architectural Woodwork Manufacturers Association of Canada, together with authorized additions and amendments will be used as a reference standard and forms part of this project specification, and as follows:
    1. Modifications made in this Section that change the requirements of the NAAWS will govern in case of conflict.

2. References to Custom or Premium Grade in this specification are as defined in the NAAWS; any item not given a specific quality grade will be Premium Grade as defined in the NAAWS.
  3. Provide a copy of the NAAWS for reference purposes on the job site.
  4. References in this specification to part and item numbers mean those parts and items contained within the NAAWS.
2. Installer: An experienced installer who has completed casework similar in material, design, and extent to that indicated and whose work has resulted in construction with a record of successful in-service performance.
  3. Fabricator: A firm experienced in producing casework similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

#### **1.8 DELIVERY STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver woodwork materials only when building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period, as follows:
  1. Deliver, store, and handle casework in accordance with NAAWS.
  2. Delivered materials that are damaged in any way or do not comply with these specifications will be rejected by the Consultant; remove rejected materials from job site and replace with acceptable materials.
2. Storage and Handling: Store products in strict accordance with fabricator written instructions for storing and handling architectural woodwork.

#### **1.9 SITE CONDITIONS**

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on Shop Drawings where casework is indicated to fit walls and other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work; locate concealed framing, blocking, and reinforcements that support woodwork by site measurements before being enclosed and indicate measurements on Shop Drawings.
2. Established Dimensions: Establish dimensions and proceed with fabricating casework without confirmed site measurements where site measurements cannot be made without delaying the Work; coordinate with the construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.
3. Ambient Conditions: Maintain area or room in which casework is being installed at a uniform temperature and humidity for 24 hours prior to, during and after installation in accordance with NAAWS for relative humidity and moisture content; provide additional lighting to maintain a minimum of 430 lx on surfaces and areas where casework is being installed.

### **2 Products**

#### **2.1 PERFORMANCE REQUIREMENTS**

1. Governing Standards: Products and installation described in this section are governed by exterior application and usage described in NAAWS 4.0, and the listed reference standards indicated in this Section and related requirements.

#### **2.2 MATERIALS**

1. Use clean stock for each type of woodwork and quality grade specified in accordance with NAAWS.

2. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 8% moisture content.
3. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage:
  1. Provide nonferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
  2. Provide toothed steel or lead expansion sleeves for drilled-in-place anchors.
4. Lumber Materials: Provide lumber materials meeting requirements for moisture content and Premium Grade in accordance with NAAWS, and as follows:
  1. Non-Exposed Softwood: Fabricator's option, meeting requirements of CSA O141, kiln dried; dressed 4 sides.
5. Panel Materials: Provide panel materials meeting requirements for moisture content and Premium Grade in accordance with NAAWS, and as follows:
  1. Industrial Particleboard: To ANSI A208.1 Grade M-2 for interior use, minimum 720 kg/m<sup>3</sup> density and Grade M-3, minimum 750 kg/m<sup>3</sup> particleboard for countertops and shelves; clearly mark panels with grade mark in visible location, extruded particleboard having loose cores with voids will not be permitted; having no added urea formaldehyde; and as follows:
    1. Acceptable Products:
      1. Vesta Particleboard, Flakeboard.
      2. Purekor Platinum Particleboard, Panel Source International.
      3. Encore SDF Sustainable Particleboard, SierraPine Ltd.
  2. Medium Density Fibreboard (MDF): To ASTM D1037 and ANSI A208.2, Premium Grade for interior use, minimum 700 kg/m<sup>3</sup> density: formaldehyde emissions shall be 0.30 ppm or less per 0.424m<sup>2</sup>/m<sup>3</sup> of room volume:
    1. Acceptable Products:
      1. Medex and Medite II MDF, SierraPine Ltd.
      2. Flakeboard Premier MDF, Flakeboard.
  3. Softwood Plywood: To CSA O121 or CSA O151, cross-banded, sanded G2S, thickness as indicated.
6. Decorative Laminate Finishes: Grades and applications in accordance with NAAWS, and as follows:
  1. High Pressure Decorative Laminate (HPDL): To CAN/CSA A172 or ANSI/NEMA LD3 composed of phenolic resin impregnated Kraft paper filler stock for Class 1 Decorative Laminate of Grade required by woodwork quality standard, colour through, and as follows:
    1. Self-Edging Work: General Purpose Grade, HGS standard duty.
    2. Liner Sheet Work: Same as for self-edging work
    3. Backing Sheet Work: BKL backing material, thickness as recommended by manufacturer to prevent warpage of surfaces, sanded on one side; furniture finish, solid white colour.
    4. Basis-of-Design Products: Refer to Drawing A141 – Finishes Plan.
    5. Additional Acceptable Products Manufacturers:
      1. Panolam Inc.
      2. Formica Corporation.
      3. Wilsonart LLC.

2. Low Pressure Decorative Laminate (LPDL): minimum 0.5 mm low pressure decorative laminate (melamine) overlay, decorative paper, and phenolic resin impregnated kraft paper with fibre reinforcing inner layers.
  1. Basis-of-Design Products: Refer to Drawing A141 – Finishes Plan.
  2. Additional Acceptable Products Manufacturers:
    1. Panolam Inc.
    2. Formica Corporation.
    3. Wilsonart LLC.
3. Solid Surfacing Material: Homogeneous 13 mm solid sheets of filled plastic resin complying with material and performance requirements in CAN/ULC S102, food zone use passing NSF 51 sanitation requirements, without a pre-coated finish, and as follows:
  1. Acceptable Products:
    1. Avonite, Inc., Avonite
    2. DuPont Polymers, Corian.
    3. Formica Corporation, Surell.
    4. Wilsonart International, Gibraltar.
4. Edge finishing for doors, drawer fronts, shelves, and false fronts:
  1. HPDL to match face.
  2. LPDL to match face.
5. Adhesives:
  1. Decorative laminate: polyvinyl acetate or aliphatic resin in accordance with manufacturer's recommendation for curing under pressure for bonding to wood cores, water resistant type.
  2. Edge banding: Thermoplastic hot melt, synthetic resin suitable for applying thin veneer wood edge banding and film overlays.

### 2.3 CASEWORK HARDWARE

1. Casework Hardware: Provide cabinet hardware described in this Section in quantity required, with necessary screws, bolts, washers for complete installation, and as follows:
  1. Fasteners:
    1. Draw Bolt Fasteners: Mitre butt joint fastener, adjustable and requiring no special tools for installation, galvanized.
    2. Non-exposed Fasteners: Fabricator's choice consistent with quality level specified.
    3. Exposed Fasteners: Architectural appearance, material, finish, and fastener tool type as selected by Consultant; coordinate sample submittals before ordering materials.
  2. Pulls:
    1. Wire Pulls: stainless steel wire pulls with nominal 100 mm centres and back plates to prevent pull out, and as follows:
      1. Acceptable Products:
        1. CBH 220-101
        2. Häfele America Co. 115.61.601
        3. Hettich Canada LP Columbus 41, 1170 122 406320
        4. Richelieu, Collection BP33205170
        5. Stanley 4484 x 101
  3. Drawer Slides: Following list of drawer slides is provided to indicate general conformance requirements only; notify the Consultant where drawer width, height or intended use differs from that indicated in the general descriptions and the requirements of the manufacturer; coordinate sample submittals before ordering materials, and as follows:

1. Low Height Drawers ( $\leq 150$  mm):  $\frac{3}{4}$  extension, rail mount, length to suit drawer box, 406 mm maximum drawer width, 22 kg capacity, side mounting with positive stop and hold-in detent features, zinc finish, and as follows:
  1. Acceptable Products:
    1. Accuride 2037.
    2. Hettich Canada LP KA3434.
    3. Häfele Canada Inc.
    4. Knappe & Vogt 8150.
  2. High Height Drawers ( $\geq 150$  mm,  $\leq 305$  mm): Full extension, length to suit drawer box; 406 mm maximum drawer width, 45 kg capacity, side mounting with positive stop, self closing, hold-in detent, and silencer features, zinc finish, and as follows:
    1. Acceptable Products:
      1. Accuride 3834.
      2. Hettich Canada LP KA5632.
      3. Häfele Canada Inc.
      4. Knappe & Vogt 8400.
4. Hinges:
  1. Typical Cabinet Doors: Concealed, euro-style hinge with cover caps; fully adjustable for overlay, depth, height and closing force; opening angle of  $110^\circ$ , self-closing feature; nickel plated steel construction; overlay and half overlay mounting, size, and profile to suit cabinet construction, and as follows:
    1. Acceptable Products:
      1. Julius Blum Canada Ltd., Modul and Expando Series.
      2. Hettich Canada LP, Intermat Soft 9943 Series.
      3. Häfele America Co., H-Series.
5. Shelf Rests:
  1. Stainless Steel Pins: Steel pin shelf supports:
    1. Acceptable Products:
      1. Richelieu, Product No. 2291180.
6. Waste and Recycling Bins:
  1. Pull out/self-closing waste and recycling bins, complete with extension slides, 76 litre capacity, 412 to 418 mm width, grey finish, two bin system, and as follows:
    1. Acceptable Products:
      1. Richelieu, Product No. 4614910.

## 2.4 ACCESSORIES

1. Shelving and Rods:
  1. Shelving: Closet shelving manufactured from any of the panel materials specified above.
  2. Shelf Brackets: To BHMA A156.9, powder-coat finished steel.
  3. Rods: Metal rod, minimum 33 mm diameter, aluminum complete with end bracket supports.
2. Sealant: One (1) part silicone to CAN/CGSB-19.13, non-staining, mould, and mildew resistant, refer to Section 07 92 00 – Joint Sealants.
3. Steel Supports: Refer to Section 05 50 00 – Metal Fabrications.
4. Spacers: Rigid PVC to size and profile indicated.
5. Hardware: Bolts, nuts, washers, screws, etc., hot-dip heavy zinc-coated.

6. Light Valance: Fabricated from same materials as casework doors to dimensions indicated, fully support by continuous aluminum seat angles.

## 2.5 CASEWORK FABRICATION

1. Fabricate casework in accordance with requirements NAAWS as applicable and as modified by this Section and Drawings.
2. Casework for High-Pressure and Low-Pressure Decorative Laminate Finish:
  1. NAAWS Quality Grade Premium Locations: As indicated on Drawings.
  2. Exposed Exterior Parts:
    1. Core: MDF.
    2. Finish: HPDL as indicated in Finishes Legend on Drawings.
  3. Exposed Interior Parts:
    1. Core: MDF.
    2. Finish: LPDL as indicated in Finishes Legend on Drawings.
  4. Semi-Exposed Parts:
    1. Core: MDF
    2. Finish: Liner Grade HPDL as indicated in Finishes Legend on Drawings
  5. Concealed Parts:
    1. Core: Same as Semi-Exposed Parts.
    2. Finish: Backer Grade HPDL at option of fabricator for balanced finish.
  6. Edge Banding for Shelves: Finished on all four (4) edges and as follows:
    1. High Pressure Decorative Laminate for HPDL Finished Surfaces: Colour to match with surface finish.
  7. Edge Banding for Doors, Drawers and False Fronts: Finished on all four (4) edges and as follows:
    1. High Pressure Decorative Laminate for HPDL Finished Surfaces: Colour to match with surface finish.
  8. Edge Banding Adhesive: Thermoplastic hot melt, synthetic resin suitable for applying thin veneer wood edge banding and film overlays.
  9. Fabricate doors and drawer fronts using flush overlay; fabricate drawers in accordance with NAAWS requirements for Grade indicated.
3. Solid Surface Countertops: Install solid surface countertops using skilled trades specializing in the type of work indicated, cut solid surface accurately to conform to shape and dimensions required with exposed surfaces true, and as follows:
  1. Perform cutting and drilling not provided by supplier.
  2. Do not use impact or hammer drills; use only diamond drill bits.
  3. Carefully cut and fit edges and grind to a perfect fit in a manner that does not impair strength or appearance.
  4. Machine polish exposed edges; do not use waxes, sealers or coatings.
  5. Patching or other forms of concealment to cover defects in material or workmanship will not be permitted.
  6. Identify the rift or pattern direction on a concealed surface of each unit. Panels shall be cut generally parallel to the rift and panels shall be cut in the same direction.
  7. Backsplash to Countertop Transition: Square splash joint.
4. Construct casework using minimum core thickness for materials listed in this section; adjust thickness of shelves to allow for uniformly distributed loading of 90 kg with a concentrated load of 23 kg and length for maximum of L/140 deflection in full use:



1. Assemble casework with flush butt hairline corners and joints; make cut outs for services on site during installation.
2. Carefully fit, cope, or mitre joints and glue with no end wood visible on finished surfaces
3. Make blocking, framing, web frames from solid lumber.
4. Provide solid wood edge strips in doors and cases to receive hardware, rebate, and pressure glue to core.
5. Cut and adapt casework to receive hardware; install finishing hardware and fittings in shop, except that fittings that may be susceptible to damage during shipping and installation may be installed after casework is installed on site.
5. Glue, dowel, mortise, lock joint or dado casework; do not use staples; nailing and screws are acceptable; do not surface nail or screw through countertops:
  1. Set nail heads in finished surfaces; countersink screws and bolt; unless specifically detailed on Drawings as being exposed; fill holes with edge grain wood plugs to match colour and grain.

### **3 Execution**

#### **3.1 EXAMINATION**

1. Visit site and note state of completion within various areas in which casework is being installed; verify that surfaces are ready to receive work of this Section and that other work is finished and painted before being built over or covered in any way by installed casework:
  1. Verify that areas in which casework is scheduled are finished and ready to accept work of this Section; with walls painted, ceilings finished, overhead services completed, tested, and accepted.
  2. Starting work will be considered as acceptance of conditions.

#### **3.2 PREPARATION**

1. Confirm access is sufficient for large pieces of casework, and that they can be transported easily and safely to final installation location.
2. Protect adjacent finished surfaces and materials from damage by work of this Section.
3. Back prime casework immediately after delivery to site.

#### **3.3 INSTALLATION**

1. Install fabricated woodwork plumb, level and true to locations indicated on Drawings and in accordance with NAAWS.
2. Anchor to floor, walls or ceiling using fastening devices and hardware consistent with materials being fastened into and quality of finish, and as follows:
  1. Do not use wood plugs.
  2. Do not use plastic plugs for ceilings or walls.
  3. Provide wall cleats fastened to wall blocking as required.
  4. Shim level and square in relation to adjoining surfaces.
  5. Scribe accurately to adjacent work.
  6. Provide allowance for finish flooring installation to base by related sections of work.
  7. Set on steel support framing; coordinate fabrication requirements with Section 05 50 00 – Metal Fabrications.
3. Scribe neatly and accurately to smooth snug fit with adjoining surfaces and materials to align work properly, mitre corners accurately.
4. Perform cutting, fitting, repairing in woodwork as required by other trades where their Work is connected to or part of this Work.

5. Cut out openings for mechanical and electrical fittings and fixtures; coordinate and cooperate with mechanical and electrical work and obtain required templates, cutting locations and dimensions.
6. Apply neat bead of sealant between plumbing fixtures countertops and adjoining walls and casework; seal edges of cut out core material before fixtures installed with moisture resistant compound.
7. Install any finishing hardware shipped loose.
8. Install solid surface countertop to casework units as follows:
  1. Install components plumb and level, in accordance with shop drawings and manufacturers written installation requirements.
  2. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
  3. Adhere under mount sinks to countertops using manufacturer's recommended adhesive and mounting hardware.
  4. Install backsplashes and end splashes as indicated on Drawings; adhere to countertops using manufacturer's standard colour matched silicone sealant.
9. Coordinate plumbing and electrical connections with Division 22 and Division 26.

### **3.4 CLOSEOUT REQUIREMENTS**

1. Adjusting:
  1. Replace, rework, or refinish work that does not meet NAAWS requirements as directed by Consultant and at no additional cost to Owner.
  2. Adjust hardware and operating parts during and after installation to provide smooth and proper operation of casework components.
2. Cleaning:
  1. Clean casework, cabinets, countertops, shelves, and fixtures, and remove marks, scratches or marring on exposed and semi-exposed surfaces after work of this Section is complete and prior to Substantial Performance for the project.
3. Protection:
  1. Protect installed products and components from damage during construction.
  2. Protect surfaces from damage until date of Substantial Performance of the Work.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies the requirements for the construction of an airtight building envelope to control infiltration and exfiltration of air by using a combined air and vapour barrier system in accordance with the Ontario Building Code (OBC).
2. Airtight components of the building include non-moisture permeable membranes, and moisture permeable membranes as specified in Related Sections, and as indicated on the Drawings.
3. Successful installation of the building envelope is dependent on, but is not limited to, the following:
  1. Coordination between the various contributors to the Building envelope installing, joining to, modifying, or otherwise affecting the installed building envelope.
  2. Scheduling and sequencing of the Work.
  3. Pre-construction meetings, inspections, tests, and related actions, including reviews performed by Contractor, inspections performed by independent agencies, and Authorities Having Jurisdiction (AHJ); they do not include contract enforcement activities performed by the Consultant.
4. Verify that the intent of constructing the Building envelope with regards to controlling air leakage into or out of conditioned spaces is achieved using training and follow-up procedures of personnel involved with installation of Building envelope materials including, but not limited to, the following characteristics:
  1. The importance of continuity of air and vapour barrier system components with all joints and penetrations sealed.
  2. The concept that air and vapour barrier system components must be structurally supported to withstand positive and negative air pressures applied to the building envelope.
  3. Installation of air and vapour barrier system components must have physical connection between:
    1. Foundation and walls.
    2. Walls to windows and doors.
    3. Different wall systems.
    4. Wall and roof transitions
    5. Wall and roof over unconditioned space.
    6. Walls, floor and roof across construction, control, and expansion joints.
    7. Walls, floors and roof to utility, pipe, and duct penetrations.
    8. Building assemblies having different interior environments.
5. Make penetrations to air and vapour barrier systems airtight.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  1. Standard 90.1-2022, Energy Standard for Buildings Except Low-Rise Residential Buildings
3. American Society for Testing Materials (ASTM International):
  1. ASTM E96/E96M-22ae1, Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
  2. ASTM E631-15, Standard Terminology of Building Constructions

3. ASTM E779-19, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
4. ASTM E1424-22, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen
5. ASTM E1677-23, Standard Specification for an Air Barrier (AB) Material or Assemblies for Low-Rise Framed Building Walls
6. ASTM E2178-21a, Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials
7. ASTM E2357-23a, Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies
4. Canadian General Standards Board (CGSB):
  1. CAN/CGSB-149.10-2019, Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method
  2. CAN/CGSB 149.15-96, Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems
5. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S741-08(R2020), Standard for Air Barrier Materials – Specifications
  2. CAN/ULC S742:2020, Standard for Air Barrier Assemblies – Specifications

#### 1.4 DEFINITIONS

1. Building Envelope: Building envelope includes the airtight and moisture resistant components including joints, junctures and transitions between materials, Products, and assemblies forming the building enclosure.
2. Vapour Retarder: Vapour retarders form an integral part of the building enclosure and must be maintained intact and continuous on the interior (warm) side of all insulated assemblies; comprised of moisture vapour impermeable membranes that are maintained in tight physical contact to the building enclosure insulation; sealed tight to all openings and penetrations and to all other elements of the Building envelope.
3. Air Barrier: Air barriers are comprised of physically strong and reliable materials designed to resist air movement into or out of the Building envelope and resist a minimum air pressure difference of 2.0 kPa without tearing, rupturing, or breaking away from its fastening; may form a part of a combined air and vapour retarder material, or may form as separate air barrier system as specified.
4. Manufacturers' use different methods of describing the rate at which water vapour will pass through their vapour retarder materials. The three most common terms are as follows:
5. Water Vapour Permeability: Time rate of water vapour transmission through unit area of flat material of unit thickness induced by unit vapour pressure difference between two specific surfaces, under specified temperature and humidity condition; arithmetic product of permeance and thickness that provides the property of a material.
6. Water Vapour Permeance: Time rate of water vapour transmission through unit area of flat material or construction induced by unit vapour pressure difference between two specific surfaces, under specified temperature and humidity conditions; permeance indicates the performance of the material and is not a property of a material.
7. Water Vapour Transmission Rate: Steady water vapour flow in unit time through unit area of a body, normal to specific parallel surfaces, under specific conditions of temperature and humidity at each surface.
8. Metric units will be used to assess the performance of any given vapour retarder material.

## 1.5 QUALITY ASSURANCE

1. Coordinate work contributing to or affecting construction of the Building envelope, and sequence of construction required to attain continuity of air barrier and vapour retarder system joints, junctures and transitions between materials and assemblies of materials and Products.
2. Use labour trained and experienced in the installation of Building envelope Products; use materials that are compatible with each other in the final construction and that will form a continuous air barrier and vapour retarder system.
3. Provide quality assurance procedures, testing and verification required to install Building envelope as follows:
  1. Include costs for Contractor's quality assurance program as a part of the Contract Price.
  2. Organize pre-construction meetings between the contributors to the Building envelope to determine extent, responsibility, and sequence of installation of airtight joints, junctures, and transitions between materials, Products and assemblies installed by the contributors to the Building envelope.
  3. Perform spot checks to verify that materials, Products, and assemblies installed by the contributors to the Building envelope are ready for review by the Owner's inspection agency.

## 2 Products

### 2.1 PERFORMANCE REQUIREMENTS

1. This Section describes coordination required between the various contributors to the successful installation of the Building envelope including any customized fabrication and installation procedures that may be required; this section does not cover specification requirements for Products listed in Related Sections.
2. Common performance requirements required to maintain continuity of the Building envelope include, but are not limited to, the following:
  1. Correct installation of Products at joints and transitions to provide airtight assemblies.
  2. Specific quality control requirements for individual construction activities are specified in the sections of the specifications; verify that each contributor to the Building envelope is adequately and satisfactorily performing the quality assurance documentation, tests and procedures required by each Related Section.
  3. Specified inspections, tests, and related actions performed by the Owner do not replace the Contractor's quality assurance procedures required to facilitate compliance with specified requirements.
3. Products used for air barrier and vapour retarder systems forming the building envelope shall be in accordance with the Ontario Building Code (OBC), and as follows:
4. Materials:
  1. Air Leakage Rate: 0.02 L/s·m<sup>2</sup> maximum measured at an air pressure differential of 75 Pa, in accordance with ASTM E2178 and CAN/ULC S741.
  2. Vapour Permeance: 3.5 ng/Pa·s·m<sup>2</sup> maximum, in accordance with ASTM E96/E96M.
5. Assemblies:
  1. Air Leakage Rate: 0.05 L/s·m<sup>2</sup> maximum measured at an air pressure differential of 75 Pa, in accordance with ASTM E1424, ASTM E1677, ASTM E2357, and CAN/ULC S742 where warm side Relative Humidity is between 27 and 55%.
  2. Vapour Permeance: 10 ng/Pa·s·m<sup>2</sup> maximum in accordance with ASTM E96/E96M where warm side Relative Humidity is between 27 and 55%.

6. Total Building:

1. Air Leakage Rate: 1.0 L/s·m<sup>2</sup> maximum measured at an air pressure differential of 75 Pa, when tested in accordance with t in accordance with CGSB 149.15, CGSB 149.10 and ASTM E779 for entire building.

**3 Execution**

**3.1 INSTALLATION**

1. Conform to the requirements of this Section to maintain and protect continuity and integrity of the building envelope and in accordance with manufacturer's written instructions, and as follows:
  1. Install air barriers and vapour retarders in full contact with substrate in accordance with manufacturer's instructions using recommended fasteners, primers or adhesives required for a complete system.
  2. Leave sufficient transition flaps of air barrier and vapour retarder materials to allow subsequent contributors to the building enclosure to complete junctions.
  3. Temporarily fasten and protect transition flaps from weather, wind, and damage from construction so that junctions can be completed without having to repair transition flaps and so that transition can form an airtight and vapour retardant seal.
  4. Maintain continuity of building enclosure across expansion and control joints whether indicated and designed or not.

**3.2 CLOSEOUT ACTIVITIES**

1. Repairing:
  1. Repair damaged construction and restore substrates and finishes when inspection, testing, sample taking, and similar services have been completed; repair immediately after testing and sampling is completed to prevent damage to assemblies resulting from moisture diffusion or air leakage.
2. Protecting:
  1. Take all necessary precautions to prevent puncturing, tearing, weakening, or damaging the building enclosure membranes during construction.
  2. Repair damage to building enclosures as directed by the Consultant.
  3. Protect vapour retarder membranes from cold in final building construction using insulation.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies the Common Work Results common to technical specification sections forming a part of fire rated assemblies and systems for installation by specialized Subcontractor's.
2. This Section specifies requirements for identifying fire and smoke-rated assemblies common to other assemblies that reference this Section. Supply and installation of identification and labelling components are the responsibility of the installing Subcontractor.
3. Fire and smoke-rated assemblies and components require installation from a single source fire stop applicator or by the Contractor or by several fire stop applicators supervised by the Contractor.
4. Design of Rated Systems is a joint responsibility of the Consultant, the Contractor, the manufacturer and installing Subcontractor, and the Authority Having Jurisdiction:
  1. Drawings indicate suggested solutions to fire rated separations, assemblies and materials using Standard Details based on generic information and time assigned materials listings listed in the Ontario Building Code (OBC) for components required to meet the intent of the fire Rated System
  2. Drawings do not portray complete assessment of all conditions associated with fire rated separations, assemblies, and materials.
  3. Delegated design requirements of this section are included to complete the required details for the Project.
  4. Delegated design submittals are required so that the Consultant can accurately and completely fulfill the requirements for the submission of schedules required by the Authorities Having Jurisdiction.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing Materials (ASTM International):
  1. ASTM E119-20, Standard Test Methods for Fire Tests of Building Construction and Materials
3. Intertek Group plc:
  1. Directory of WH Listed Building Products
  2. Directory of ETL Listed Electrical and Electronic Products
4. National Fire Protection Association (NFPA):
  1. NFPA 80-2022, Standard for Fire Doors and Other Opening Protectives
  2. NFPA 251-2006, Standard Methods of Tests of Fire Resistance of Building Construction and Materials
5. Underwriters Laboratories Inc.(UL):
  1. UL Fire Resistive Assemblies and Systems, Certified for Canada (CUL)
6. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S101-14, Standard Method of Fire Endurance Tests of Building Constriction and Materials

2. CAN/ULC S114:2018, Standard Method of Test for Determination of Non-Combustibility in Building Materials
3. CAN/ULC S115-2018, Standard Method of Fire Tests of Firestop Systems

#### 1.4 DEFINITIONS

1. Authority Having Jurisdiction: The Ontario Building Code (OBC) authority responsible for reviewing Engineered Judgements, Rated Systems and Mock-Ups (if any), and for inspecting installed Rated Systems for compliance with local codes and ordinances.
2. Certified Fire Protection Specialist (CFPS): Person who has completed the NFPA sanctioned examination and professional accreditation, who is directly employed by the manufacturer, and who has direct experience in the preparation of Engineered Judgements.
3. Engineered Judgement: A written proposal submitted by the manufacturer to the Authority Having Jurisdiction arising from a variation in the assembly or system from that tested and labelled in their Rated Systems, and as follows:
  1. Engineered Judgements are specific to this Project and details described in the written proposal and form a part of the Submittal requirements for this Section.
  2. Engineered Judgements must be signed by a CFPS and form a part of the delegated design submittal required by this section and Section 01 35 73 – Delegated Design Procedures.
4. Manufacturer's Authorized Representative: A person who is directly employed by the manufacturer and who is capable of making onsite decisions relating to the installation of the manufacturers Products; this person is specifically noted as not being an employee of a distributor, agent, or other supplier.
5. Fire-Resistance Rating: The fire-resistance rating is the time, in minutes or hours, that a materials or assembly of material will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in the Ontario Building Code (OBC) and as required by the Authority Having Jurisdiction. The test and acceptance criteria referred to in the Ontario Building Code (OBC) are contained in a standard fire test method, CAN/ULC S101 and CAN/ULC S115.
6. Smoke Barriers and Partitions: Sealed Barriers, partitions and other assemblies that limit the spread of smoke and toxic gases, and as follows:
  1. Assemblies: The construction of Smoke Barriers is identical to a minimum 1-hour Fire-Resistance Rating as described ins this Section. Assemblies do not require ULC Fire-Resistant Assembly Listing.
  2. Leakage Rate: Smoke Barriers require to be sealed to limit the passage of smoke and toxic gases at ambient and elevated temperatures to a maximum of 25 litres/s•m<sup>2</sup> when subjected to a pressure differential of 75 Pa at 24°C and 200°C.
7. Fire-Protection Rating: The time, in minutes or hours, that a closure (doors, frames, door hardware, shutters, fire dampers and fire glass screens) will withstand the passage of flame when exposed to fire.
8. Fire Compartment: Enclosed spaces in a building that are separated from all other parts of the building by enclosing construction providing a fire separation having a required fire-resistance rating.
9. Firewall: Type of fire separation constructed of non-combustible construction that subdivides a building or separates adjoining buildings to resist the spread of fire and that has a fire-resistance rating as prescribed in the Building Code and has structural stability to remain intact under fire conditions for the required fire-rated time.



10. Recognized Testing Authority: An organization recognized by the Authority Having Jurisdiction as being capable of conducting testing and providing labelling for materials, assemblies and systems that include, but are not limited to, the following organizations:

1. Underwriters Laboratories of Canada (ULC).
2. Underwriters Laboratories Inc. (UL).
3. Warnock Hersey (intertek) and Electrical Testing Labs (ETL) Listed
4. ETL, UL and WH labelling will only be acceptable subject to the following conditions:
  1. Fire resistance rated assemblies and materials bearing an Underwriters Laboratories Inc. (UL) or Warnock Hersey (WH) label will be acceptable for use on this project provided that the label indicates acceptance under Underwriters Laboratories of Canada (ULC) and having one of the following CUL, CULUS, CWH or CWHUS markings.
  2. Materials that only have UL, ULUS, WH or WHUS markings are not acceptable.
5. Examples of acceptable marks from Recognized Testing Authorities:



11. Standard Details: Details prepared by the Consultant indicating an assembly based on generic materials demonstrating configuration and proposed methods for attaining the required fire rating; Standard Details may be derived from the following criteria:

1. Details may be based on specific Rated Systems provided by a Recognized Testing Authority.
2. Details may be based on time assigned to materials listed in the Ontario Building Code (OBC).
3. Details are of a general nature only, sufficient to inform the bidders of the Consultant's design intent, and do not portray every instance or requirement that can be represented on the Project site; the supplier of materials is responsible submitting design information for firestopping, and smoke seal systems required for the Project to the Consultant prior to starting work.

## 1.5 ADMINISTRATIVE REQUIREMENTS

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with the requirements of Section 01 31 19 – Project Meetings to discuss proposed fire-resistance rated systems supplied and installed by the Subcontractor and manufacturer, modifications to the Consultant's Standard Details, Engineered Judgements, placement of identification labels and coordination issues, and as follows:
  1. Attendees for meetings include the Consultant, Contractor, installing Subcontractor's, Manufacturer's Authorized Representatives; the Authority Having Jurisdiction can be invited as a courtesy, but it is not mandatory that they attend the meeting.
2. Design fire resistive assemblies, firestopping and smoke seals required by the Contract Documents to withstand fire ratings indicated on Drawings and in accordance with requirements of the applicable Building Code:
  1. Provide manufacturers standard details where site conditions match standard assembly listings.
  2. Provide manufacturers Engineered Judgment, indicating acceptance by the Authority Having Jurisdiction, signed by manufacturer's CFPS designer, where assembly does not match standard assembly listing.
  3. Conform Proposed Rated System materials and methods to applicable codes and ordinances of the Authority Having Jurisdiction.

4. Additional performance requirements are listed in the referenced technical specification sections.
5. Validate proposed Engineered Judgement using a third-party testing agency as required by Authority Having Jurisdiction.
3. Conform to the following requirements to maintain the continuity of fire separations whether shown on the Drawings or not:
  1. Subcontractor requires notifying the Contractor where assigned work penetrates through a fire separation or removes installed fire-resistant materials. Subcontractor will require to repair any damage to maintain integrity of fire separations and as follows:
  2. Contractor must notify the Consultant before penetrating load-bearing assemblies that do not have a predetermined penetration location. fire resistance rated systems do not re-establish the structural integrity of load-bearing partitions or assemblies or support live loads and traffic.
  3. Rated Systems can be either “built-in” (such as integral with concrete placement) or “post-installed”; provide built-in Rated System devices before concrete placement or masonry installation.
  4. Coordinate sizing of sleeves, openings, core drilled holes, or cut openings to accommodate penetrations through fire and smoke-rated separations.
  5. Coordinate construction of openings and penetration items and verify that Fire Resistance Rated systems are installed according to specified requirements.
4. Scheduling: Schedule required site visits, submission requirements and documentation procedures, review of Mock-Ups (if any) and inspection of fire and smoke rated assemblies as follows:
  1. Authority Having Jurisdiction: Notify Authority Having Jurisdiction in sufficient time to allow for inspection prior to Fire-Resistance Rated systems being covered up or enclosed.
5. Sequencing: Sequence installation of fire and smoke rated components to maintain the continuity of fire separations whether shown on the drawings or not:
  1. Fire separations may not be pierced by electrical or similar service outlets except in accordance with Ontario Building Code (OBC).
  2. Do not support non-combustible construction on combustible construction.
  3. Fire Stop openings in non-combustible construction that terminates at the exterior wall, the underside of floor, ceiling, or roof structures, and at floors with non-combustible materials.
  4. Do not use combustible members, fastenings, and similar items to anchor fixtures to fire separations.
  5. Fire Stop openings for non-combustible pipes and ducts to prevent the passage of smoke and flame.

## 1.6 SUBMITTALS

1. Submit a summary of Rated Systems proposed for use in the Project within four (4) weeks of starting work of the Contract in accordance with Section 01 33 00 - Submittal Procedures, and as follows:
  1. Provide summary of manufacturer’s details and Engineered Judgements in a format similar to that attached to the end of this Section.
  2. Attach detailed sketches and drawings, manufacturer’s written installation instruction, and material safety and data sheets to the summary, fully cross referenced to the Drawings and the summary.
  3. Manufacturer’s Details:
    1. Submit manufacturer’s details indicating an assembly or system that matches the design intent provided by the Standard Details
    2. Provide additional details as required to address additional detail conditions not covered by the Standard Details.

4. Engineered Judgements (EJs):
  1. Manufacturer's details indicating a modification to an assembly or system required to meet the design intent provided by the Standard Details or to address a specific site condition not normally test for in the manufacturer's testing program.
  2. Engineered Judgments must include project name and Subcontractor's name who will install Rated System described in the Engineered Judgement.
  3. Engineered Judgements must be signed by a CFPS employed by the manufacturer, and who was directly responsible for preparation of the Engineered Judgement.
  4. Prepare Engineered Judgements in accordance with IFC Guidelines for Evaluating Firestop Systems Engineering Judgements.
5. Equivalent Fire Resistance Rated Assembly (EFRRA): Fire-Resistance Rated Assemblies that are submitted by a Fire Stop manufacturer using similar materials and configurations as components from a competing Fire Stop manufacturer, but that has not been tested by the submitting Fire Stop manufacturer:
  1. An EFRRA is not qualified by exactly representative fire testing but will be viewed as an acceptable solution provided that an engineering assessment is performed by the Fire Stop manufacturer.
  2. EFRRA's will be administered the same as EJs as described in this Section.
2. Delegated Design Submittals: Submit Commitment to General Reviews by Architects and Engineers and Letter of General Conformance for EJ and EFRRA designs in accordance with Section 01 35 73 – Delegated Design Procedures.

#### 1.7 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

#### 1.8 QUALITY ASSURANCE

1. Coordination of Related Work: Quality Assurance requirements specific to Fire-Resistance Rated assemblies, materials and components must be read in conjunction with requirements of this Section to form a complete requirement for the Project.
2. Quality Assurance Program: Subcontractor are response for establishing a Quality Assurance program in accordance with FCIA Manual of Practice, assemble a listing of proposed Fire Stop systems and assemblies required for the project, and submit required certificates at completion of the Project that work associated with Fire and Smoke assemblies has been completed in accordance with referenced standards, and with specifications.
3. Installers: Fire-Resistance Rated systems specified for the Project will be supplied and installed by a Subcontractor specializing in the application of specific systems and that have completed training in a ULC or FM Fire Stop training and certification program, and as follows:
  1. Fire Stopping: Specified in Section 07 84 00 – Firestopping for mechanical and electrical penetrations, floor, and wall openings, top-of-wall seals, perimeter building seals and re-enterable cable management systems.
4. Manufacturer's Site Services: Manufacturer's authorized representative (not distributor or agent) will be onsite during initial installation of Fire-Resistance Rated systems to train Subcontractor's personnel in proper selection and installation procedures in accordance with manufacturer's written recommendations.

## 2 Products

### 2.1 PERFORMANCE REQUIREMENTS

1. Provide Rated Systems identical to those tested in assembly indicated by the Recognized Testing Authority; provide Engineered Judgements for systems that do not match the Rated Systems.
2. Provide a label and proof of fire resistive materials used in Rated Systems issued by a Recognized Testing Authority.
3. Refer to technical sections for specific requirements for sealing penetrations and joints of smoke and fire separations.

### 2.2 MATERIALS

1. Provide Rated Systems composed of components that are compatible with each other, the substrates they are applied to, and the items (if any) penetrating the Rated System under conditions of service and application as demonstrated by the manufacturer based on testing and site experience.
2. Provide complete components for each Rated System that are needed to properly install material forming the system; use only components specified by the manufacturer and approved by the Recognized Testing Agency for the designated fire resistance rated systems.

### 2.3 IDENTIFICATION MATERIALS

1. Adhesive Labels: Nominal 75 mm high x 125 mm wide self-adhering labels placed adjacent to fire and smoke rated penetration components, printed with the following information:
  1. ATTENTION: FIRE RATED PENETRATION ASSEMBLY DO NOT MODIFY HOUR RATING AND CLASS OF PENETRATION ASSEMBLY
  2. Name of Fire Stopping manufacturer.
  3. Names of products used.
  4. Manufacturers standard detail number, or Engineering Judgement identifier; ULC or CUL Number.
  5. Date Installed.
  6. Subcontractor's Name.
  7. Installer's Name.
  8. Phone number for repair or replacement of Fire Stopping materials.
  9. QR Code for easy information retrieval.
  10. Placement: Place self-adhering labels on a permanent surface adjacent to Fire Stopping installation in an inconspicuous location in fully finished areas, and as follows:
    1. Acceptable locations include areas such as within concealed ceiling spaces, above cable trays, out of direct line-of-sight beside penetrations and similar locations.
    2. Confirm locations before final placement.
11. Example:



2. Stencil Signs: Nominal 300 mm high by 400 mm wide painted and stencilled permanent signage applied to fire walls, fire barriers and partitions, smoke barriers and partitions and other wall or floor assemblies containing protected openings and penetrations labelled with the following information:
  1. ATTENTION: FIRE RATED BARRIER – PROTECT ALL OPENINGS  
HOUR RATING OF ASSEMBLY  
OR (as applicable to installation)  
ATTENTION: SMOKE RATED BARRIER – PROTECT ALL OPENINGS
  2. Placement: Apply stencilled signage to wall or barrier surface at 10 metre intervals, evenly laid out across the length of the assembly at a concealed locations and as follows:
    1. Acceptable locations include areas such as above finished ceilings, or out of direct line-of-sight in finished public spaces.
    2. Acceptable exposed locations include areas such as within unoccupied spaces, mechanical and electrical rooms, and similar unfinished non-public spaces.
    3. Confirm locations before final placement.
  3. Self-adhering labels containing similar information and sized similarly to site stencilled signage are considered as an acceptable substitution for stencilled and painted signage.
  4. Example:



### 3 Execution

#### 3.1 RESPONSIBILITIES OF PARTIES INVOLVED

1. The Consultant is responsible for the following:
  1. Provide Standard Details of Fire-Resistance Rated systems for the guidance of the Contractor, Subcontractors, and Authority Having Jurisdiction; Standard Details represent design intent only, and do not portray every condition that may arise in the construction process.
  2. Review manufacturer's submittals for conformance to design intent to comply with the Consultant's requirements for completing schedules required by the Building Code.
2. The Contractor is responsible for the following:
  1. Direct Subcontractors responsible for installation of Fire-Resistance Rated systems to submit a summary of Fire-Resistance Rated systems used in the project for submission to the Authority Having Jurisdiction and the Consultant.
  2. Direct Subcontractors responsible for installation of Fire-Resistance Rated systems to complete any Mock-Ups required by the technical specification sections ready for review by the Authority Having Jurisdiction and the Consultant.
  3. Direct the Subcontractor to submit Letters of Commitment and Compliance to the Consultant.
  4. Direct the Subcontractor to notify the Authority Having Jurisdiction to inspect installed Fire-Resistance Rated systems.

3. The Authority Having Jurisdiction will be responsible for the following:
  1. Review manufacturer's submittals for compliance with local codes and ordinances submitted by Consultant, when requested by the Authority Having Jurisdiction.
  2. Review Mock-Ups for compliance with local codes and ordinances when they are able to attend (optional attendance).
  3. Review of installed Fire-Resistance Rated systems for compliance with local codes and ordinances.

### **3.2 SITE QUALITY CONTROL**

1. Manufacturer's Site Services: Refer to RELATED REQUIREMENTS for relating to manufacturer's site review and reporting requirements, and as follows:
  1. Notify Consultant a minimum of seven days in advance of completion of installation of fire and smoke Fire-Resistance Rated systems and Fire Stop installations; confirm dates and times on days preceding each series of installations.
  2. Do not cover up fire and smoke rated construction or Fire Stop systems that will become concealed behind other construction until Consultant has reviewed, and Authority Having Jurisdiction's building inspector have examined each installation.

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### 3.1 SAMPLE SUMMARY FORM

- The following Sample Summary Form can be used to develop the listing of Fire-Resistance Rated systems required for the Project as indicated:

RATED SYSTEM SUMMARY SHEET			
Project Name:		Date:	
Project Address:			
Installing Subcontractor:		Telephone:	
Installer's Address:			
Submitted to:			
PENETRATIONS THROUGH WALL ASSEMBLIES			
Type of Penetration	Combustible or Non-Combustible Penetrating Material	F Rating	Design or Listing Number
PERIMETER SEALS, TOP-OF-WALL DETAILS AND OTHER FIRE STOPPING			
Type of Penetration	Combustible or Non-Combustible Material	FT or F Rating	Design or Listing Number
CONCRETE FIRE PENETRATIONS – VERTICAL			
Type of Penetration	Combustible or Non-Combustible Material	FT Rating	Design or Listing Number

END OF SECTION

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of self-adhering waterproofing membranes including surface preparation and accessories required for a complete waterproofing system.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. American Society for Testing and Materials (ASTM International):
  1. ASTM D1621-16(2023), Standard Test Method for Compressive Properties of Rigid Cellular Plastics
  2. ASTM D5295/D5295M-18, Standard Guide for Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems
2. Canadian Standards Association (CSA Group):
  1. CSA A123.23-15 (R2020), Product specification for polymer-modified bitumen sheet, prefabricated and reinforced

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Arrange a pre-construction meeting in accordance with Section 01 31 19 – Project Meetings attended by Contractor, Consultant, Owner and installing Subcontractor, and others affected by work of this Section to discuss and confirm requirements for waterproofing, including the following:
  1. Surface preparation specified under other Sections.
  2. Substrate condition and pre-treatment.
  3. Minimum curing period.
  4. Forecasted weather conditions.
  5. Special details and sheet flashings.
  6. Installation procedures.
  7. Testing and inspection procedures.
  8. Protection and repairs.
2. Coordination: Coordinate with work affected by other Sections for placement of drainage panels, weeping tile systems and placement of backfilling so that installation of work of this Section is completed without interruption and to minimize exposure of membranes to UV effects of sunlight.

### **1.5 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Submit the following before starting any work of this Section:
  1. Product Data:
    1. Submit copies of the most current technical data sheets, describing materials physical properties, and explanations about product installation, including installation techniques, restrictions, limitations and other manufacturer recommendations, and as follows:



2. Submit membrane manufacturer's standard details that will be used for this project, indicate changes that must be made to make the details project specific for review by the Consultant.
3. Informational Submittals: Submit the following before starting work of this Section:
  1. Compatibility Certificate: Submit a written certification that waterproofing membrane products and components are compatible with adjacent air barrier membranes specified in Section 07 27 16 – Air Barrier Membrane.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## **1.6 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Installer: Use a qualified installer who is authorized, approved, or licensed by waterproofing manufacturer to install manufacturer's products, and having experience with installations of similar complexity and scope.
  2. Source of Supply: Obtain waterproofing materials and protection course panels from one source from a single manufacturer.

## **1.7 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver products to the Project site in original wrapping with seals unbroken, labelled with manufacturer's name, product brand name and type, production date, and directions for storage and handling.
2. Storage and Handling Requirements: Store products in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer, and as follows:
  1. Prevent prolonged exposure to sunlight.
  2. Do not store products on the structure in concentrations that exceed the design live load.

## **1.8 SITE CONDITIONS**

1. Ambient Conditions: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer.

## **1.9 WARRANTY**

1. Manufacturer's Warranty: Submit written warranty, signed by waterproofing manufacturer agreeing to repair or replace waterproofing that does not comply with requirements or that does not remain watertight for a period of five (5) years covering products and two (2) years covering installation dated from Substantial Performance of the Work.

# **2 Products**

## **2.1 MANUFACTURERS**

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. GCP Applied Technologies Construction Products.

2. IKO Industries Ltd.
  3. Soprema.
  4. W.R. Meadows.
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Low Temperature Performance: Modify acceptable material listings and provide manufacturer's low temperature or ultra-low temperature membrane products when installation conditions are scheduled to occur at or below installation temperature range of specified materials.

## 2.3 MATERIALS

1. Self-Adhering Waterproofing Membrane: Self-adhering SBS modified bituminous waterproofing membrane having cross laminated high density polyethylene film laminated to top face and minimum nominal thickness of 1.5 mm, meeting the requirements of CSA A123.23, Type B, Grade 3, and as follows:
  1. Basis-of-Design Products: Henry Company, Blueskin WP 200.

## 2.4 ACCESSORIES

1. Primer: Manufacturer's standard, factory formulated polyurethane or epoxy primer.
2. Membrane Adhesive: Cold adhesive mastic composed of a bituminous binder, added to bonding agents and solvents compatible with specified waterproofing membranes.
3. Termination and Joint Sealant: Multi-component polyurethane sealant, compatible with waterproofing; and as recommended by membrane manufacturer for substrate and joint conditions.
4. Protection Board: Rigid polypropylene or asphaltic board as required by manufacturer to protect membranes during backfilling operations.
5. Drainage Panels: high strength three-dimensional polymeric core drain board with a non-woven geotextile fabric fully bonded to the top dimples of the core, and as follows:
  1. Compressive Strength: Nominal 720 kPa in accordance with ASTM D1621.
  2. Minimum Flow Rate: Vertical, Nominal 6113 L/min/m<sup>2</sup>.
  3. Basis-of-Design Products: Henry Company, Bakor DB 6000.
6. Rigid Insulation: Refer to Section 07 21 13 – Board Insulation.
7. Filter Fabric: Non-woven geotextile made up of polypropylene fibers, UV resistant, providing a minimum water flow rate of 155 g/m/ft<sup>2</sup> and a tensile strength of 40 kg, and as follows:
  1. Basis-of-Design Products: Henry Company, Filter Fabric N04.

## 3 Execution

### 3.1 EXAMINATION

1. Examine surfaces and conditions affecting waterproofing and report any detrimental conditions before proceeding with any work of this Section and as follows:
  1. Verify that concrete has cured and aged for minimum time recommended by waterproofing manufacturer.
  2. Verify that substrate is visibly dry and free of moisture, and that capillarity is below manufacturers written tolerances.
2. Test concrete surfaces for moisture using manufacturer's required moisture testing methods; installation will represent installer's acceptance of conditions.

### 3.2 PREPARATION

1. Surface Preparation: Clean and prepare substrate in accordance with ASTM D5295/D5295M and manufacturer's written recommendations, and as follows:
  1. Remove grease, oil, bitumen, form release agents, paints, curing compounds, and other penetrating contaminants or film forming coatings from concrete.
  2. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.
2. Preparation at Terminations and Penetrations: Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves in accordance with manufacturer's written instructions and as follows:
  1. Prime substrate in accordance with waterproofing manufacturer's written instructions.
  2. Apply double thickness of waterproofing and embed joint reinforcing strip in preparation coat.
  3. Provide sealant cants around penetrations and at inside corners of deck-to-wall butt joints.
3. Joint and Crack Treatment: Prepare, treat, rout, and fill joints and cracks in substrate in accordance with manufacturer's written instructions, and as follows:
  1. Remove dust and dirt from joints and cracks before coating surfaces.
  2. Apply bond breaker between sealant and preparation strip.
  3. Prime substrate and apply a single thickness of preparation strip extending minimum 75 mm along each side of joint.
  4. Apply double thickness of waterproofing and embed joint reinforcing strip in preparation coat.
  5. Install sheet flashing and bond to deck and wall substrates where indicated or as required by waterproofing manufacturer's written instructions; extend sheet flashings onto perpendicular surfaces and other work penetrating substrate.

### 3.3 INSTALLATION

1. Waterproofing Application: Apply waterproofing in accordance manufacturer's written instructions after concrete has cured to acceptable moisture levels and vapour emissions, and not less than fourteen (14) days after concrete forms are removed and as follows:
  1. Start installing waterproofing in presence of manufacturer's technical representative.
  2. Apply primer over prepared substrate.
  3. Install waterproofing membranes to surfaces, single layer for vertical surfaces.
2. Protection Board: Apply manufacturer's required waterproofing protection covering when required by manufacturer and at locations where drainage composites are not used; provide methods for protecting waterproofing membranes from backfilling operations and methods for repair when protection coverings are not required by manufacturer.
3. Drainage Panels: Install in accordance with manufacturer's written instructions; unadhered directly over all areas of the newly applied membrane, extending to walls, curbs, and other related junctures.
4. Filter Fabric: Install filter fabric in accordance with manufacturer's instructions.

### 3.4 CLOSEOUT ACTIVITIES

1. Repairing: Repair damaged materials as recommended by waterproofing manufacturer.
2. Cleaning: Remove protective materials immediately prior to acceptance.
3. Protection: Protect waterproofing from adjacent construction operations.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specified requirements for supply and installation of board insulation forming part of a continuous thermal component of the building enclosure, at the following locations:
  1. Foundation walls (exterior and interior application).
  2. Foundation perimeter.
  3. Under slabs-on-grade.
  4. In loadbearing applications.
  5. Within exterior wall assemblies.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. American Society for Testing Materials (ASTM International):
  1. ASTM C1303/C1303M-19, Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
  2. ASTM D1621-16, Standard Test Method for Compressive Properties of Rigid Cellular Plastics
  3. ASTM D2842-19, Standard Test Methods for Water Absorption of Rigid Cellular Plastics
2. Canadian General Standards Board (CGSB):
  1. CGSB 71-GP-24M, Adhesive, Flexible, for Bonding Cellular Polystyrene
3. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S114:2018, Standard Method of Test for Determination of Non-Combustibility in Building Materials
  3. CAN/ULC S701.1:2017, Standard for Thermal Insulation, Polystyrene, Boards
  4. CAN/ULC S702.1-14 (R2019), Standard for Mineral Fibre Thermal Insulation for Buildings
  5. CAN/ULC S702.2-15, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 2: Installation
  6. CAN/ULC S704.1:2017, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced
  7. CAN/ULC S770-15, Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams
  8. CAN/ULC S773-09, Standard for Thermal Insulation Terminology

### **1.4 DEFINITIONS**

1. Long Term Thermal Resistance (LTTR): Defined as using techniques from ASTM C1303/C1303M or CAN/ULC S770 determining a foam's R-Value is equivalent to the average performance of a permeably faced foam insulation product over fifteen (15) years.

### **1.5 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Submit the following information before starting any work of this Section:
  1. Product Data: Submit copies of the most current technical data sheets, describing materials, physical properties, product installation, restrictions and limitations, and any other manufacturer's recommendations, and as follows:

2. Provide two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## **1.6 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance: Deliver products in manufacturers original packaging and in accordance with manufacturer's written instructions.
2. Storage and Handling:
  1. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location; follow manufacturer's written instructions for handling, storing, and protecting during installation.
  2. Protect plastic insulation as follows:
  3. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
  4. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
  5. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## **2 Products**

### **2.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Atlas.
  2. DuPont.
  3. IKO Commercial.
  4. Johns Mansville.
  5. Owens-Corning.
  6. Soprema Canada.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### **2.2 REGULATORY REQUIREMENTS**

1. Environmental Regulations: Provide insulation products that meet or contain less than the regulated limits for Ozone Depletion Potential compounds listed in the Montreal Protocol adopted by the United Nations Environmental Program.
2. Fire-Resistance Rating: Provide materials that meet requirements for CAN/ULC S102 for flame spread rating of 25 or less; CAN/ULC S114 for non-combustibility; and CAN/ULC S129 for smoulder resistance when using materials in fire-resistant rated construction.

### **2.3 MATERIALS**

1. Foundation Wall Insulation: XPS board insulation in accordance with CAN/ULC S701.1, Type 4, LTTR not less than RSI 0.80/25 mm; square edges, board size 610 mm x 2440 mm x thickness required to achieve insulation value indicated on Drawings; minimum compressive strength 210 kPa at 10% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in accordance with ASTM D2842, and as follows:

1. Acceptable Products:
  1. DuPont, Styrofoam SM.
  2. Owens-Corning, Foamular C-300.
  3. Soprema, SOPRA-XPS 30.
2. Perimeter Insulation: Concrete faced XPS board insulation meeting requirements of CAN/ULC S701.1, Type 4, LTTR not less than RSI 0.87/25 mm; minimum compressive strength 240 kPa at 10% deformation in accordance with ASTM D1621; water absorption maximum 0.7% (% by volume) when measured in accordance with ASTM D2842, and as follows:
  1. Edges: Tongue and groove edges along long edges; butt edges along short edges
  2. Dimensions: 610 mm x 1220 mm x 75 mm insulation thickness.
  3. Topping: 8 mm thick latex modified concrete topping, grey coloured with broom textured finish.
  4. Accessories: Galvanized steel mounting clips-2 per panel; 33 mm long concrete screws, top J-channel flashing min. 100 mm x panel thickness x min 57 mm leg.
  5. Acceptable Products:
    1. Tech-Crete Processors Ltd., CFI-Wall Panels.
    2. T. Clear Corporation, WallGUARD Wall Panels.
3. Under Slab: XPS board insulation in accordance with CAN/ULC S701.1, Type 4, LTTR not less than RSI 0.80/25 mm; square edges, board size 406 mm x 2440 mm x thickness required to achieve insulation value indicated on Drawings; minimum compressive strength 210 kPa at 10% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in accordance with ASTM D2842, and as follows:
  1. Acceptable Products:
    1. DuPont, Styrofoam SM.
    2. Owens-Corning, Foamular C-300.
    3. Soprema, SOPRA-XPS 30.
4. Load Bearing Insulation: XPS board insulation, load bearing type in accordance with CAN/ULC S701.1, Type 4, LTTR not less than RSI 0.87/25 mm; square edges, board size 610 mm x 2440 mm x thickness required to achieve insulation value indicated on Drawings; minimum compressive strength 410 kPa at 5% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in accordance with ASTM D2842, and as follows:
  1. Acceptable Products:
    1. DuPont Styrofoam, Hiload 60.
    2. Owens-Corning, Foamular 600.
5. Cavity Insulation: Foil faced polyisocyanurate, preformed rigid board insulation manufactured in accordance with CAN/ULC S704.1, Type 1, Class 2, LTTR not less than 1.05/25 mm, flame spread and smoke density classifications <100/<450 in accordance with CAN/ULC S102, square edges, manufacturer's standard maximum size x thickness required to achieve insulation value indicated on Drawings, and as follows:
  1. Acceptable Products:
    1. Atlas, EnergyShield.
    2. IKO, Enerfoil Sheathing.
    3. Johns Mansville, AP Foil-Faced Sheathing.

## 2.4 ACCESSORIES

1. Brick Veneer Fasteners: Refer to Section 04 05 19 – Masonry Anchorage and Reinforcement, for fasteners integral with installation of insulation.

2. Insulation Fasteners:
  1. Mechanical Fasteners: High quality, impact resistant plastic insulation or galvanized metal insulation stay, and fastener system specifically designed for installation of board insulation with self-tapping steel stud framing screw or and self-drilling concrete/masonry screw as applicable; minimum 45 mm diameter, screw length and diameter to suit insulation thickness, corrosion protected fastener, and as follows:
    1. Acceptable Products: Installation specific substitutions will be considered for this material:
      1. DekFast, ES Insulation Assembly.
      2. EJOT, ejotherm STR Assembly.
      3. ITW Grid-Mate Flat Backed Washer.
      4. Hilti, Insulation Plate.
    2. Insulation Clips: Impale type, perforated 50 mm x 50 mm cold rolled carbon steel 0.912 mm core metal thickness, adhesive mounted; 2.657 mm diameter annealed steel wire spindle, length to suit insulation, 25 mm diameter self locking washers, and as follows:
      1. Acceptable Products:
        1. Gemco Insulation Fasteners, Insulation Hanger; substitutions will be considered for this material.
  3. Perimeter Insulation Fasteners: Concrete faced insulation manufacturer's standard concealed fasteners with groove mounting plate and fastening spline.
  4. Insulation Adhesive:
    1. Trowelable Polystyrene Insulation Adhesive: Trowel consistency, synthetic rubber-based insulation adhesive compatible with polystyrene insulation in accordance with CGSB 71-GP-24M; suitable for application to temperature of -10°C or lower:
      1. Acceptable Products:
        1. Bakor, 230-21 Rigid Insulation Adhesive; substitutions will be considered for this material.
  5. Protection Board: Pre-moulded, semi-rigid asphalt/fibre composition board, minimum 6 mm thick, formed under heat and pressure as recommended by board insulation manufacturer for below grade installations.
  6. Perimeter Insulation Accessories: Coordinate supply of end closures and flashings for perimeter insulation system with Section 07 62 00 – Joint Sealants and manufacturer recommended accessories required for complete installation as follows:
    1. Air Barrier Membrane: Refer to Section 07 27 16 – Air Barrier Membrane.
    2. Gaskets to Adjacent Substrates: Standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant; colour to match adjacent colour
  7. Sealants to Adjacent Substrates: Refer to Section 07 92 00 – Joint Sealants, non-staining, non-shrinking and non-sagging type compatible with substrate materials; colour as selected by Consultant.
  8. Clips and Fasteners: Manufacturer's standard material as supplied with perimeter insulation materials.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine substrates and conditions for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
2. Verify that all surfaces which are to receive rigid insulation are clean, free of deleterious matter and are sufficiently level to allow the proper installation of insulation.
3. Verify that all flashings provided under other Sections are installed and that they divert moisture to exterior of insulated systems.

#### 3.2 PREPARATION

1. Clean substrates of substances harmful to insulations; remove projections that interfere with insulation attachment.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.3 INSTALLATION

1. Install insulation and accessories in accordance with manufacturer's written instructions applicable to products and application indicated, and as follows:
  1. Use insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.
  2. Maintain continuous thermal insulation, vapour barrier and air tightness for building spaces and elements, and as follows:
    1. Saw cut and trim insulation neatly to fit spaces; fill voids with foamed-in-place insulation compatible with installed insulation, refer to Section 07 21 19 – Foamed-in-Place Insulation.
    2. Butt edges and ends tight.
    3. Fit insulation tight against mechanical, electrical, and other items protruding through the plane of insulation.
    4. Use insulation free of broken or chipped edges.
    5. Apply single layer of insulation to produce thickness indicated unless multiple layers are otherwise specifically shown or required to make up total thickness.
    6. Fit insulation firmly against substrate using mechanical fasteners spaced in accordance with manufacturers recommended spacing and pattern; in addition, adhere insulation to uneven substrate surfaces and provide additional fasteners to eliminate air spaces between insulation and substrate.
    7. Mechanically fasten insulation boards 50 mm in from edges at 300 mm centres.
  3. Leave insulation joints unbonded over line of expansion and control joints; bond a continuous 150 mm wide strip of primary vapour membrane over expansion and control joints using compatible adhesive
  4. Protect insulation from damage until it is covered; replace any broken, sunburned, crushed, or dented insulation immediately prior to covering; coordinate with backfilling operations
2. Perimeter Insulation: Install board insulation to vertical surfaces with adhesive applied in accordance with manufacturer's written instructions, and as follows:
  1. Interior Application: Extend boards a minimum of 600 mm vertically below bottom of finish floor slab, installed on inside face of perimeter foundation walls.
  2. Apply adhesive to the substrate by the "dab" method not less than 10 mm x 20 mm size at 150 mm centres; bed the insulation in the adhesive before the adhesive loses its tack or skins over.
  3. Protect below grade insulation on vertical surfaces from damage during backfilling by applying protection board; set in adhesive according to insulation manufacturer's written instructions.



3. Concrete Faced Perimeter Insulation: Install in accordance with manufacturer's written instructions, and as follows:
  1. Fasten board insulation using manufacturer recommended fastening system
  2. Cover exposed insulation at corners and top of perimeter insulation with prefinished flashing as specified in Section 07 62 00 – Sheet Metal Flashing and Trim.
  3. Install boards vertically in accordance with manufacturers written instructions.
4. Under Slab Insulation: Extend boards as indicated on Drawings, and as follows:
  1. Lay boards on level compacted fill.
  2. Protect top surface of horizontal insulation from damage during concrete work by applying protection board.
  3. Insulate structural slabs at entrances with insulation placed horizontally underneath the concrete and insulate surrounding slabs on grade in the same way for a distance of 1200 mm in every direction from the perimeter of the structural slab; omit perimeter insulation on adjacent foundations for the width of the structural slab.
5. Load Bearing Insulation: Install in accordance with manufacturer's written instructions, and as follows:
  1. Load Bearing Insulation: Install board insulation horizontally having a minimum compressive strength of 410 kPa to locations indicated on Drawings.
6. Perimeter Heating Duct Application: Install in accordance with manufacturer's written instructions, and as follows:
  1. Compact walls of heating duct trench to form solid backing
  2. Attach insulation boards to perimeter foundation wall extending from underside of finish floor to 100 mm below bottom of heating duct
  3. Lay insulation boards in bottom of heating duct trench and extend to 150 mm beyond heating duct and 600 mm minimum from inside face of perimeter foundation wall.
  4. Secure insulation in place to prevent displacement.
7. Cavity Wall Insulation:
  1. Fit courses of insulation between wall ties and other confining obstructions in cavity; butt edges tightly in vertical and horizontal directions.
  2. Install cavity insulation with a tight fit to substrate materials, provide adhesive and additional fasteners where uneven substrates cause air spaces behind insulation; apply adhesive to substrate in a continuous film not less than 3 mm thick when wet and bed the insulation into adhesive before adhesive loses its tack or skins-over.
  3. Apply insulation fasteners using a minimum of six (6) fasteners in two rows located near the centre of the board along the narrow dimension and near the third points along the long dimension; secure boards with two clips at the centre where both dimensions are less than 600 mm.
  4. Coordinate application of cavity wall insulation with installation of masonry ties and anchors specified in Section 04 05 19 – Masonry Anchorage and Reinforcement.

### 3.4 CLOSEOUT ACTIVITIES

1. Protection:
  1. Protect installed board insulation from damage due to harmful weather exposures, physical abuse, and other causes.
  2. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of blanket insulation for installation in ceiling spaces and concealed spaces that form part of a thermal component of the building envelope.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM C1320-20, Standard Practice for Installation of Mineral Fiber Batt, and Blanket Thermal Insulation for Light Frame Construction
3. Canadian Standards Association (CSA Group):
  1. CSA B111-1974 (R2003), Wire Nails, Spikes and Staples
  2. CSA B149.1:20, Natural Gas and Propane Installation Code, Includes Errata (2020), Ontario Amendments (2021), and Administrative Update (2021)
  3. CSA B149.2:20, Propane Storage and Handling Code
4. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S114:2018, Standard Method of Test for Determination of Non-Combustibility in Building Materials
  3. CAN/ULC S129-15, Standard Method of Test for Smoulder Resistance of Insulation (Basket Method)
  4. CAN/ULC S702.1-14, Standard for Mineral Fibre Thermal Insulation for Buildings
  5. ULC S702.2-15, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 2: Installation

### **1.4 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified in this Section.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.5 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

### **1.6 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Delivery products to site in accordance with manufacturer's written instructions.

2. Storage and Handling Requirements: Protect insulation materials from physical damage and from deterioration by moisture and soiling; store undercover and protect from wetting or moisture.

## **2 Products**

### **2.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. CertainTeed Corporation
  2. Johns-Manville Corporation
  3. Knauf Insulation
  4. Owens-Corning Canada Inc.
  5. Roxul Inc.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitution Procedures.

### **2.2 PERFORMANCE REQUIREMENTS**

1. Regulatory Requirements: Provide materials that meet requirements for CAN/ULC S102 for flame spread rating of 25 or less; CAN/ULC S114 for non-combustibility; and CAN/ULC S129 for smoulder resistance when using materials in fire resistant rated construction.

### **2.3 MATERIALS**

1. Mineral Fibre Thermal Insulation: Unfaced, preformed mineral slag batt insulation in accordance with CAN/ULC S702.1, Type 1; having a nominal RSI of 0.67/25 mm; rated non-combustible in accordance with CAN/ULC S114 and having a flame spread rating of 5 or less in accordance with CAN/ULC S102; density 32 kg/m<sup>3</sup>; square edges, thickness as required to meet design insulation values indicated on drawings or as required to fill insulated spaces where not indicated, and as follows:
  1. Acceptable Products:
    1. Owens-Corning, Thermafiber Safing.
    2. ROCKWOOL, ComfortBatt.

### **2.4 ACCESSORIES**

1. Nails: Galvanized steel, length to suit insulation plus 25 mm, to CSA B111.
2. Staples: 12 mm minimum leg.
3. Tape: As recommended by manufacturer.
4. Vapour Retarder: Refer to Section 07 26 00 – Polyethylene Vapour Retarders.

## **3 Execution**

### **3.1 EXAMINATION**

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

1. Batt Insulation: Install batt insulation where indicated and where required to maintain continuity of thermal insulation of the building envelope in accordance with ASTM C1320 or ULC S702.2, and as follows:
  1. Install thermal insulation with continuous vapour retarder on the warm side of installation.
  2. Cut and trim insulation neatly to fit spaces; butt ends and edges tight; fit insulation tightly to framing members and around pipes, conduits, and projecting structural members within insulated spaces and in miscellaneous voids and cavity spaces where required to reduce thermal bridging.
  3. Fill stud space of exterior framed walls with insulation full depth of stud only where no insulation/vapour retardant indicated on exterior face of stud walls.
  4. Do not compress insulation to fit into spaces.
  5. Fit insulation closely around electrical boxes, pipes, ducts, frames, and other objects in or passing through insulation.
  6. Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum vents Type L or Type B in accordance with CSA B149.1 and CSA B149.2.
  7. Fill stud space of temporary partitions with insulation.
  8. Hold insulation in position with clips, wires or as recommended by manufacturer when insulation is installed in horizontal locations.

### 3.3 CLOSEOUT ACTIVITIES

1. Protection:
  1. Protect installed insulation from damage arising from harmful weather exposures, physical abuse, and other causes.
  2. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements for supply and installation of closed cell, medium density foamed-in-place insulation providing a fully integrated building envelope system functioning as the primary thermal enclosure and providing a continuous air and vapour barrier seal at perimeters of steel doors and frames, aluminum windows, and around protrusions through the exterior wall envelope and juncture of different cladding materials.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM D6226-21, Standard Test Method for Open Cell Content of Rigid Cellular Plastics
3. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S124:2018 (R2023), Standard Method of Test for the Evaluation of Thermal Barriers for Foamed Plastic
  3. CAN/ULC S127-14-R2019, Standard Corner Wall Method of Test for Flammability Characteristics of Non-Melting Foam Plastic Building Materials
  4. CAN/ULC S705.1:2018, Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Material Specification
  5. CAN/ULC S705.2:2020, Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Application
  6. CAN/ULC S770-15, Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams

### 1.4 DEFINITIONS

1. HCFC Free: Zero Global Warming, Zero Ozone Depletion (ODP) in compliance with Montreal Protocol requirement to eliminate production of HCFC 141b; products using HFC-245fa will be given preference over all other products.
2. LTTR (Long Term Thermal Resistance): Defined as using techniques from CAN/ULC S770 predicting foam's insulating value that has been shown to be equivalent to the average performance of a permeably faced foam insulation product over 15 years.
3. Certification Organization Agencies: Third Party Quality Assurance Agencies recognized by CAN/ULC S705.2 such as Morrison Hershfield, Intertek Testing or Canadian Urethane Foam Contractors Association Ltd. (CUFCA) are acceptable to the Consultant; other organizations may also be acceptable provided they are listed in Manufacturer's CCMC Documentation and that information indicating equivalency to listed CO's ability to administer SPF QAP is provided before starting work of this Section.

## **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, the Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to placement of foamed-in-place insulation, surface preparation and priming, installation requirements for transitions and flexible membranes bridging to adjacent membranes, and thermal barrier requirements for polyurethane foam exposed to interior spaces in final assembly.
2. Sequence: Sequence work of this Section so that work for closures and substrates are concurrently with work for this Section.

## **1.6 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's product data sheets for each type of material, including manufacturer's printed instructions for evaluating, preparing, and treating substrate, temperature and other limitations of installation conditions, technical data, tested physical and performance properties, and thermal barrier materials used in final construction.
3. Informational Submittals: Provide the following submittals during the course of the Work:
  1. Company License: Photocopy of Subcontractor's Certification Organization license, current for the term of the Contract and listing of certified installers used for the project.
  2. Installer Certificates: Photocopies of each installers applicator identification cards indicating certification for installation of foamed-in-place materials as thermal insulation, and as air and vapour barriers.
  3. Onsite Documentation and Installation Instructions: Make manufacturer's installation instructions and daily testing reports available for viewing when requested by Consultant during installation period of materials specified in this Section.
  4. Material Certificates: Submit certificate of compatibility by foamed-in-place insulation manufacturer, listing all materials on the project that it connects to or that come in contact with it, and documentation confirming that materials meet requirements for an air and vapour barrier.
  5. Source Quality Control Submittals: Submit testing results performed by an accredited laboratory confirming material has been tested and conforms to the requirements listed Reference Standards.
  6. Site Quality Control Submittals: Submit SPF Quality Assurance Program (QAP) documentation and reports in accordance with requirements listed in this Section at completion of work.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## **1.7 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

## **1.8 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:

1. Manufacturer: Obtain foamed-in-place insulation materials from a single manufacturer regularly engaged in manufacturing the products specified in this Section and that manufacturer's material conforming to the requirements of CAN/ULC S705.1.
2. Subcontractor: Use only Subcontractor that are licensed as required by CAN/ULC S705.2
3. Installers: Use companies having trained and certified installers in accordance with CAN/ULC S705.2 and by the foamed-in-place insulation manufacturer.

#### **1.9 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver materials to Project site in original packages with seals unbroken, labelled with manufacturer's name, product, date of manufacture, expiration date, and directions for storage.
2. Storage and Handling Requirements: Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by foamed-in-place insulation manufacturer, and as follows:
  1. Protect stored materials from direct sunlight.
  2. Avoid spillage; immediately notify Contractor if spillage occurs and start cleaning up procedures; clean spills and leave area as it was prior to spill.

#### **1.10 SITE CONDITIONS**

1. Ambient Conditions: Apply foamed-in-place insulation within range of ambient and substrate temperatures recommended by foamed-in-place insulation manufacturer; do not apply foamed-in-place insulation to frozen, damp or wet substrates.

#### **1.11 WARRANTY**

1. Warranty: Provide manufacturer's standard two (2) years warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

### **2 Products**

#### **2.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Master Builders Solutions.
  2. CertainTeed-Saint Gobain.
  3. Huntsman Building Solutions.
  4. Icynene Inc.
  5. Johns Manville.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitution Procedures.

#### **2.2 PERFORMANCE REQUIREMENTS**

1. Regulatory Requirements: Provide insulation that meet requirements for non-ozone depleting materials as regulated in the Montreal Protocol adopted by the United Nations Environmental Program and that have been tested for Fire Resistance in accordance with CAN/ULC S102 and CAN/ULC S127.

## 2.3 MATERIALS

1. Sprayed Polyurethane Foam Insulation (SPFI): Two component, polyurethane resin and polyol, closed cell foamed-in-place insulation containing recycled materials in accordance with CAN/ULC S705.1 and having the following minimum properties:
  1. Vapour Permeance: Less than  $60 \text{ ng/P}\cdot\text{s}\cdot\text{m}^2$  qualifying as a vapour retarder in applied thicknesses of 50 mm and greater.
  2. Air Leakage Rate: Maximum  $0.02 \text{ L/s}\cdot\text{m}^2$  at 75 Pa.
  3. Long Term Thermal Resistance: Nominal RSI 0.9/25 mm in accordance with CAN/ULC S770.
  4. Density: Nominal  $35 \text{ kg/m}^3 \pm 10\%$  by weight.
  5. Closed Cell Content: Minimum 95% in accordance with ASTM D6226.
  6. Ozone Depletion Potential: Zero.
  7. Global Warming Potential: Low.
  8. Volatile Organic Compounds: Zero.
  9. Acceptable Products:
    1. Walltite v.5 by BASF.
    2. CertaSpray by CertainTeed Sait-Gobain.
    3. Heatlok Soya HFO by Huntsman Building Solutions.
    4. MD-C-200 by Icynene Inc.
    5. M Corbond MCS by Johns Manville.
2. Thermal Barrier (Flame Spread Protection): Use thermal barrier materials meeting requirements of CAN/ULC S124 and the Ontario Building Code (OBC) requirements for 15-minute thermal barrier for any foamed-in-place insulation exposed to building interior after final installation; thin film intumescent and ignition suppressing coatings are not acceptable for work of this project.
  1. Acceptable Products:
    1. Southwest Type 7TB by Carboline.
    2. CafcoBlaze-Shield II by Isolatek International.
    3. Monokote Z-3306 by GCP Applied Technologies.
3. Equipment: Use equipment recommended by manufacturer for specific type of installation and in accordance with CAN/ULC S705.2.
4. Primer: Manufacturer's recommended primer specific to steel and aluminum surfaces subject to forming oils or grease such as steel studs, girts, and plastic piping materials.

## 2.4 ACCESSORIES

1. Manufacturer's recommended materials required for a complete and functioning vapour resistant, air and thermal barrier.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

1. Protection of Existing Conditions: Mask and cover adjacent areas; protect other surfaces from overspray and as follows:
  1. Verify that any required foam stops or back up materials are in place to prevent over spray and achieve complete seal.
  2. Seal off existing ventilation equipment; install temporary ducting and fans to remove exhaust fumes; provide for make-up air.



3. Erect barriers, isolate area, and post warning signs to advise non-protected personnel to avoid the spray area.
2. Surface Preparation: Clean, prepare, and treat substrate in accordance with CAN/ULC S705.2, manufacturer's written instructions, and as follows:
  1. Provide clean, dust free, and dry substrate ready for installation of foamed-in-place insulation.
  2. Clean and prime metal and plastic surfaces to remove grease and oil that have potential to impair bond of foamed-in-place materials to substrates in accordance with manufacturer's written requirements.
  3. Prime other substrates appropriate to the materials that foamed-in-place foam is being bonded to when recommended by manufacturer.
  4. Apply foamed-in-place insulation materials in layers to achieve required bond to transition membranes and to prevent membrane damage arising from exothermic heating; allow for drying time between coats; protect self adhered membranes in accordance with manufacturer's written requirements.
  5. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through foamed-in-place insulation and at protrusions according to foamed-in-place insulation manufacturer's written instructions.

### 3.3 INSTALLATION

1. Apply foamed-in-place insulation to thickness required to achieve RSI-Value (R-Value) indicated on the drawings and to achieve required vapour barrier properties, without voids, with foam continuous at corners and junctions, and as follows:
  1. Install transition membranes to adjacent surfaces and ensure proper adhesion of transition membranes to substrate, compatible with spray polyurethane foam insulation in accordance with manufacturer's written instructions.
  2. Install flashings, counter flashings, and metal transitions in accordance with manufacturer's written instructions.
  3. Spray polyurethane foam within surface and environmental limitations indicated by CAN/ULC S705.2 and manufacturer's written instructions.
  4. Finish foam surface free from voids and embedded foreign objects.
  5. Remove masking materials and over spray from adjacent areas immediately after foam surface has hardened; clean adjacent surfaces using cleaning methods that do not damage work performed by other Sections.
  6. Trim any excess thickness that interferes with the application of cladding or covering materials installed by other Sections.
  7. Tolerances: -6 mm, +10 mm maximum variation from required thickness.

### 3.4 SITE QUALITY CONTROL

1. Manufacturer's Site Services: Manufacturers Quality Assurance Program: Perform manufacturer's SPF QAP inspections and testing using recognized inspection agency and submit written reports and testing information; include costs for QAP as a part of the work of this Section.
2. Non-Conforming Work: Repair or replace non-conforming work and re-test to verify that installation meets specified requirements.

### 3.5 CLOSEOUT ACTIVITIES

1. Cleaning:
  1. Cut back excess foamed-in-place thermal, air and vapour barrier once cured flush with surrounding surfaces.
  2. Recess foam where application of sealants is required.
  3. Clean adjacent surfaces of overspray and dusting.

2. Protecting: Protect completed work from exposure to ultraviolet light in accordance with manufacturer's written requirements.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of polyethylene vapour retarders complete with accessories required to provide an effective and continuous vapour retarder forming a part of the complete building envelope system.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. Canadian General Standards Board (CGSB):
  1. CAN/CGSB-51.34-M86, Vapour Retarder, Polyethylene Sheet, for Use in Building Construction
3. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, the Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to installation of polyethylene vapour retarders.

### **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including product characteristics, performance criteria, limitations, installation sequence, cleaning procedures, and joint treatment and repair recommendations.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

## **2 Products**

### **2.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Balcan Plastics Limited.
  2. Layfield Canada Ltd.

3. Lexsuco 2010 Corporation.
  4. Mercury Plastics of Canada Inc.
  5. Polytarp Products.
  6. Regency Plastics Co.
  7. W. Ralston (Canada) Inc.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitution Procedures.

## **2.2 MATERIALS**

1. Polyethylene Vapour Retarder: To CAN/CGSB-51.34, 0.15mm thick with a water vapour permeance of not greater than 45 ng/(P·s·m<sup>2</sup>), flame spread rating of less than 150 to CAN/ULC S102.

## **2.3 ACCESSORIES**

1. Joint Sealing Tape: Air resistant pressure sensitive adhesive tape, type recommended by vapour retarder manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.
2. Sealant: Asbestos-free non-hardening sealant, compatible with vapour retarder materials, recommended by vapour retarder manufacturer in accordance with Section 07 92 00 – Joint Sealants.
3. Staples: Minimum 6 mm leg.

# **3 Execution**

## **3.1 EXAMINATION**

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

## **3.2 INSTALLATION**

1. Verify that services are installed and have been accepted by the Consultant and Authorities Having Jurisdiction (AHJ) prior to installation of vapour retarder.
2. Install sheet vapour retarder on warm side of exterior ceiling assemblies prior to installation of gypsum or cementitious board to form continuous retarder in accordance with manufacturers written instructions.
3. Use sheets of largest practical size to minimize joints.
4. Install materials in a manner that maintains continuity; repair punctures and tears with sealing tape before work is concealed.

## **3.3 EXTERIOR SURFACE OPENINGS**

1. Cut sheet vapour retarder to form openings and lap and seal to window and door frames in accordance with good building envelope practice.

## **3.4 PERIMETER SEALS**

1. Seal perimeter of sheet vapour retarder as follows:
  1. Apply continuous bead of sealant to substrate at perimeter of sheets.
  2. Lap sheet over sealant and press into sealant bead.
  3. Install staples through lapped sheets at sealant bead into wood substrate.
  4. Install sealant bead with no gaps; smooth out folds and ripples occurring in sheet over sealant.

### **3.5 LAP JOINT SEALS**

1. Seal lap joints of sheet vapour retarder as follows:
  1. Attach first sheet to substrate.
  2. Apply continuous bead of sealant over solid backing at joint.
  3. Lap adjoining sheet minimum 150 mm and press into sealant bead.
  4. Install staples through lapped sheets at sealant bead into wood substrate.
  5. Install sealant bead with no gaps; smooth out folds and ripples occurring in sheet over sealant.

### **3.6 CLOSEOUT ACTIVITIES**

1. Cleaning: Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.
2. Protecting: Protect polyethylene vapour retarder system from damage during application and remainder of construction period, according to manufacturer's written instructions.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of below grade vapour retarder including all accessories required for a complete sealed system.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.
2. Division 31 – Earthwork

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Concrete Institute (ACI):
  1. ACI 302.1R-15, Guide for Concrete Floor and Slab Construction
3. American Society for Testing and Materials (ASTM International):
  1. ASTM D1434-23, Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheet
  2. ASTM E1643-18a, Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
  3. ASTM E1745-17(2023), Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
4. Canadian Standards Association (CSA Group):
  1. CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
5. International Standards Organization (ISO):
  1. ISO/TS 11665-13:2017, Measurement of Radioactivity in the Environment – Air: Radon 222 – Part 13: Determination of the Diffusion coefficient in Waterproof Materials: Membrane Two-Side Activity Concentration Test Method

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate delivery of specified materials to coincide with placement of underslab granular materials, prior to installation of reinforcing steel and concrete, and as follows:
  1. Concrete Slabs in Contact with Grade: Coordinate reinforced concrete slab with requirements described in Structural Drawings and Specifications for the following requirements:
    1. Concrete Mix Design: Coordinate mix design to reduce quantity of cracks in and reduce water content to account for impermeable membrane in direct contact with concrete slab.
    2. Reinforcing Steel: Coordinate type of reinforcing steel carriers or chairs to distribute point loads and minimize the number of accidental penetrations and repairs to the impermeable membrane.
    3. Concrete Placement: Coordinate placement of concrete using methods that reduce potential for displacement or puncturing of the impermeable membrane.
    4. Sealants: Confirm sealant types and compatible with joint types and installation conditions in accordance with Section 07 92 00 – Joint Sealants for slab perimeter, around penetrations and openings to prevent soil gases from entering the building.

2. Underslab Services: Coordinate placement of underslab utilities and other penetrations through impermeable membrane so that they are complete before installation of below grade vapour retarder and application of sealants and pre-manufactured transition boots.
3. Concealed Roughed-In Risers: Coordinate with Drawings for location of access panels when risers are installed within permanent construction; coordinate location of a panels so they are located at riser connection point.
4. Protection of Installed Products: Performance of membranes and depressurization components is heavily dependent on quality of installation, resistance to damage after installation and integrity of sealants applied to penetrations through and perimeters of concrete slabs; enforce quality management program procedures to prevent puncturing, tearing, weakening, or damaging of membranes during construction; and repair any damage occurring as work progresses.

### 1.5 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including technical information relating to specified materials, listing of accessory materials required for complete installation and manufacturer's written installation instructions.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### 1.6 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
2. Storage and Handling Requirements: Store materials in a clean, dry area in accordance with manufacturer's instructions; protect materials during handling and application to prevent damage or contamination.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Stego Industries LLC.
  2. W.R. Meadows.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitution Procedures.

### 2.2 MATERIALS

1. Below Grade Vapour Retarder: Premanufactured Impermeable Membranes: High density, puncture resistant co-extruded plastic sheet membrane purposely manufactured for contact with soil or granular fill under concrete slabs meeting specified performance requirements as follows:
  1. Tensile Strength and Puncture Resistance: Minimum 12.4 kN/m tensile strength and 2200 g puncture resistance in accordance with ASTM E1745 Class A.
  2. Water Vapour Permeance: Nominal 0.50 ng/Pa·s·m<sup>2</sup> (0.0086 Perm) maximum in accordance with ASTM E1745 after conditioning.

3. Radon Permittivity: Maximum  $8.7 \times 10^{-12} \text{ m}^2/\text{s}$  in accordance with ISO/TS 11665, Method C (K124/02/95).
4. Methane Permeability: Maximum Gas Transmission Rate (GTR) nominal  $190 \text{ mL/m}^2\text{-day}$  in accordance with ASTM D1434.
5. Thickness: Minimum  $375 \text{ }\mu\text{m}$  (15 mil).
6. Acceptable Products:
  1. Stego Wrap 15 Mil Vapor Barrier (15-Mil) by Stego Industries, LLC.
  2. Perminator HP 15 Mil Underslab Vapor Barrier by W.R. Meadows, Inc.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Subgrade Preparation: Prepare subgrade in accordance with Division 31 – Earthwork ready for installation of below grade vapour retarder materials specified in this Section.
2. Foundation Preparation: Remove adhered mud and other substances deleterious to adhesion of membrane accessories to concrete slab surfaces and utility penetrations.

#### 3.3 INSTALLATION

1. Install below grade vapour retarder in accordance with manufacturer's written instructions and ASTM E1643, and as follows:
  1. Unroll membrane with the longest dimension parallel to direction of concrete placement.
  2. Install below grade vapour retarder under and in direct contact with concrete slab, and as follows:
    1. Membrane Continuity: Overlap edges, apply manufacturer's compatible seam tape, and seal penetrations to form a continuous membrane.
    2. Prevent bleed water and paste from concrete placement.
    3. Membrane Termination: Adhere edges of below grade vapour retarder to face of vertical concrete surfaces to form continuous connection to impervious building elements.
  3. Seal penetrations including pipe and conduit risers in accordance with manufacturer's written instructions.
  4. Make no additional penetrations except as required for placing of reinforcing steel and permanent utilities.
  5. Install sealants in accordance with Section 07 92 00 – Joint Sealants to full perimeter of floor between slab edge and foundation, full circumference of penetrations through the slab, and joints between separately installed floor slabs to maintain an effective seal.

#### 3.4 CLOSEOUT ACTIVITIES

1. Repairing: Repair damaged areas by cutting patches of membrane; sized to overlap damaged area a minimum of 150 mm to each side of puncture; and tape all sides using manufacturer's required tape or patching materials.

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of weather resistant, breather type air barrier membrane, accessories and installation applied over exterior wall sheathing to provide an effective and continuous air barrier forming a part of the complete building envelope system.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM E2178-21a, Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials
3. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 51.32-M77, Sheathing, Membrane, Breather Type

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's product literature, and written installation instructions for evaluating, preparing, and treating each substrate, technical data, and tested physical and performance properties of products.
  2. Shop Drawings: Submit shop drawings showing locations and extent of air barrier membrane materials, accessories, and assemblies specific to Project conditions. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction. Include details of interfaces with other materials that form part of air barrier.
3. Informational Submittals: Provide the following submittals during the course of the Work:
  1. Product Certificates: Submit product certificates from air barrier membrane manufacturer certifying compatibility of air barrier membrane and accessory materials with Project materials that connect to or that come in contact with air barrier membrane.
  2. Product Test Reports: Submit product test reports for each air barrier membrane assembly, for tests performance by a qualified testing agency.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.5 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Manufacturer: Obtain air barrier materials through one source from a single manufacturer
  2. Installer: Use an installation company that is acceptable to the manufacturer, using workers who are trained and approved by the membrane manufacturer having experience with projects of similar complexity and area.

## 1.6 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver materials to job site in original unopened packages, clearly marked with manufacturer's name, material brand name and description of contents.
2. Storage and Handling Requirements: Protect membrane materials before, during and after installation in accordance with manufacturer's requirements for weight, temperature, heat and flame, and humidity; store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by membrane manufacturer.

## 1.7 SITE CONDITIONS

1. Ambient Conditions: Install air barrier membrane within the range of ambient and substrate temperatures recommended in writing by air barrier membrane manufacturer, and as follows:
  1. Protect substrates from environmental conditions that affect air barrier membrane performance.
  2. Do not apply air barrier membrane to a damp or wet substrate or during snow, rain, fog, or mist.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Henry Company.
  2. Soprema Canada.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitution Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Provide materials and installations that meet the following material and assembly performance ratings, and as follows:
  1. Material Performance: Provide materials having an air permeance rating not exceeding 0.02 l/sec-m<sup>2</sup> measured at 75 Pa pressure differential in accordance with ASTM E2178.

### 2.3 MATERIALS

1. Primer: Manufacturer's recommended primer or surface conditioner compatible with substrate to improve bond between membranes to substrates.
2. Air Barrier Membrane: Self-adhered air barrier meeting requirements of ASTM E2178, and as follows:
  1. Acceptable Products:
    1. Henry, Blueskin VP160.
    2. Soprema, Sopraseal Stick VP.

### 2.4 ACCESSORIES

1. Sealant: Gun grade asphaltic compound recommended by sheathing paper manufacturer for use sealing lap joints.

2. Provide manufacturer's recommended mastics, fasteners, and adhesives as required for a complete installation.

### **3 Execution**

#### **3.1 EXAMINATION**

1. Examine conditions of substrates and other conditions affecting this Section before starting work; notify other related trades and verify that substrates are complete and ready for installation of products specified in this Section.

#### **3.2 INSTALLATION**

1. Prepare surfaces in accordance with manufacturer's written requirements for type of substrate; free from voids, spalled areas, loose aggregates or sharp points; clean surfaces to remove contaminants that could affect bond such as grease or wax, dust, dirt and debris and as follows:
2. Exterior Gypsum Sheathing: Verify that boards are sufficiently stabilized with corners and edges fastened with appropriate screws; pre-treat board joints with reinforced self-adhesive tape or fibreglass mesh tape; fill gaps wider than 6 mm with mastic or sealant and allow sufficient time to fully cure before applying tape and liquid applied membrane.
3. Install air barrier membrane in accordance with manufacturer's written instructions.

#### **3.3 CLOSEOUT ACTIVITIES**

1. Protection: Protect air barrier from environmental exposure as recommended by manufacturer.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies the requirements for the design, supply, and installation of thermally improved cladding support systems.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
  1. ASHRAE 90.1-2022 (I-P), Standard 90.1-2022 (I-P Edition) -- Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings (ANSI Approved; IES Co-sponsored)
4. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S114:2018, Standard Method of Test for Determination of Non-Combustibility in Building Materials
  3. CAN/ULC S134-13, Standard Method of Fire Test of Exterior Wall Assemblies

### **1.4 DEFINITIONS**

1. Continuous Insulation R-Value: Thermal resistance rating of insulation materials measured as a decrease from the Rated R-Value of Insulation as modified by thermal bridges, fasteners, penetrations, and openings through the opaque surface of the building envelope.
2. Rated R-Value of Insulation: Thermal resistance rating of primary insulation materials using values as specified by the manufacturer of insulating materials; added to any insulation contained in framing cavities or insulated sheathing materials, but not including thermal resistance contributed by other building materials or air films.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meetings: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, the Consultant, materials supplier(s), and other relevant personnel before commencement of Work for this Section to review methods and procedures related to thermally improved cladding support systems including, but not limited to, the following:
  1. Approaches to shop drawings and other required submittals and coordination required to align specified building cladding system expectations with design principles listed in this Section.
  2. Sequence and scheduling for installation of thermally improved cladding systems and coordination for preparation of substrates.
  3. Review methods and procedures related to installation, including manufacturer's written instructions for installation of thermally improved cladding support systems.
  4. Identify any concerns for substrate conditions that could affect manufacturer's installation requirements for thermally improved cladding support systems.
  5. Review temporary protection measures required during and after installation.

2. Coordination: Coordinate the Work of this Section with installation of sheathing systems and air and vapour membranes for layout and attachment to structural substrates.
3. Sequencing: Sequence work so that installation of thermally improved cladding systems and support framing coincides with installation of substrate preparation without causing delay to the Work.

#### 1.6 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of thermally improved cladding support product specified including manufacturer's written preparation requirements and installation instructions.
  2. Shop Drawings: Submit shop drawings cladding support systems, required coordination of fastening and attachment of cladding and façade materials, panel layout and accessories.
3. Informational Submittals: Provide the following submittals during the course of the Work:
  1. Certifications:
    1. Qualification Certification: Submit qualification statement or certificate stating that fabricator and installer of thermally improved cladding support systems are approved by the cladding manufacturer and have the necessary tools, equipment, and expertise to undertake the work specified in this Section.
    2. Compliance Certification: Provide certificates from panel and thermally improved cladding support systems manufacturer indicating tested performance requirements required by Authorities Having Jurisdiction (AHJ) for flame spread performance, compatibility of materials and wind load resistance.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.7 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Manufacturer: Obtain materials from a source having resources to design thermally improved cladding support systems compatible with the cladding products specified in related requirements.
  2. Installers: Execute Work of this Section using qualified personnel skilled in installation of work of this Section, having experience with installations similar in material, design, and extent to that indicated for this project.
  3. Design Engineer: Retain a professional engineer; registered in the province of the Work, to design fabrication and erection of the Work of this Section in accordance with the Ontario Building Code (OBC) and Contract Documents requirements including the following:
    1. Seal and signature to shop drawings and design submittals.
    2. Site review and certification of installed components.
    3. Manufacturer's Engineering Recommendations: Perform design calculations for stiffness and load bearing capacity for thermally improved cladding support system in accordance with written recommendations from panel manufacturer for deflection and attachment requirements.
    4. Verify system and panel thicknesses based on maximum deflections provided by panel manufacturer and to suit building location and configuration.

#### 1.8 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.

2. Storage and Handling Requirements:
  1. Store and handle products in strict compliance with manufacturer's written instructions and recommendations.
  2. Protect from damage due to weather, excessive temperature, and construction operations.

## 1.9 SITE CONDITIONS

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where specified products are indicated to fit together with other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Established Dimensions: Establish dimensions and proceed with fabricating specified products without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for shimming and fitting.

## 1.10 WARRANTY

1. Warranty: Provide manufacturer's standard ten (10) years warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Cascadia Clip by Cascadia Windows and Doors.
  2. ISO Clip by Northern Facades.
  3. NVELOPE Rain Screen Support Systems by SFS.
  4. Rain Screen Attachment System by Knight Wall Systems.
  5. TAC Thermal Spacer System by Exterior Technologies Group.
  6. TClip by Engineered Assemblies.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Regulatory Requirements: Provide panels that are listed and labelled in accordance with CAN/ULC S102, CAN/ULC S114 and CAN/ULC S134 for fire endurance and flame spread testing.
2. Design Responsibility: Professional engineer retained by thermally improved cladding support system manufacturer is responsible for designing support assembly and confirming panel thicknesses and connections based on design loads appropriate for the project, and verifying that installation meets requirements of the AHJ.
3. System Description: Plans, elevations, details, characteristics, and other requirements indicated are based upon materials and details are not intended to limit selection of cladding support systems to a single manufacturer, and as follows:
  1. Provide a rear ventilated rain screen system in accordance with good design practices as established by Canada Mortgage and Housing Corporation for curtain wall assemblies and as further described in this Section.

2. Provide a system that has no visible fasteners, telegraphing or fastening on the exposed panel faces or other components that detract from a neat and flat finished appearance.
  3. Provide a system that does not place restraints on panel that could result in compressive skin stresses for panel products, and that will maintain a flat panel appearance regardless of temperature change.
  4. Listing of Acceptable Products is not intended to denote support for these systems or exclude other systems from being proposed for substitution; engineered assemblies not forming a part of a proprietary system will also be considered.
  5. Selection of thermally improved cladding support systems is a joint coordination effort between the building cladding manufacturer and fabricator of thermally improved cladding support systems.
4. Thermal Improvement Requirements: Design thermally improved cladding support system to provide a measurable improvement when compared to conventional thermal performance of full depth cladding support systems as follows:
1. Design thermally improved cladding support systems to provide Continuous Insulation R-Value retaining a minimum of 80% Rated R-Value indicated for opaque wall areas.
  2. Design thermally improved cladding support system to account for thermal movement of local climate with a minimum of 60°C ambient or cladding panel temperature fluctuations, without causing undue stress on fasteners or panel or other detrimental effects.
  3. Design thermally improved cladding support system as a complete system to accommodate structural movement in wall system and between wall system and building structure, without permanent distortion, damage to infill materials, or racking of joints.
  4. Design thermally improved cladding support system members and suspension system to withstand gravity load, live loads and negative loads calculated in accordance with the Ontario Building Code (OBC).
5. Ventilation Requirements: Rear ventilated assembly with designed air space at top and bottom of building, at each wall termination, and perimeter of openings to maintain airflow behind cladding panels, and as follows:
1. Design cavity ventilation to maintain continuous airflow at cladding penetrations and interruptions; do not block vertical airflow at windows, doors, eaves, or at the base of the building.
  2. Design width of ventilation cavity between rear of panels and exterior sheathing to account for building height and floor-to-floor structural offsets.
6. Structural Requirements: Design structural panel supports to provide a minimum L/300 deflection stiffness or as required by cladding panel manufacturer; and that limits deflection of cladding panels to a maximum of L/180 at other required serviceability limit states established by cladding materials manufacturer and as follows:
1. Wind Load: Determine wind loads using post disaster importance factors listed in the Ontario Building Code (OBC) for deflection and strength, modified by the appropriate exposure, gust and pressure (internal and external) factors in accordance with the Ontario Building Code (OBC) structural commentaries.
  2. Deflection Limitation: Maximum deflection listed above is based on system weight plus wind load (positive and negative) loads acting normal to plane of installation under 1 in 50-year sustained wind loading, and as follows:
    1. Maximum deflection criteria apply to horizontal plane of system, width, and length, as well as vertical deflection.
    2. Provide additional stiffeners and fasteners to prevent excessive deflection.
  3. Building Movement: Include provisions to accommodate movement in thermally improved cladding support systems and between cladding panels and building structure where these movements are caused by deflection or movement of building structure.

4. Drainage: Provide for positive drainage to the exterior of all water entering or condensation occurring within the system in accordance with NRC Rain Screen Principles.

## 2.3 MATERIALS

1. Closure Protection/Vent Screen: Manufacturer's recommended material comprised of compressible open-cell U/V stabilised polyether polyurethane foam or other screening material that provides the following:
  1. Air Flow: Minimum of 50% free area, thickness to fill ventilation cavity between rear of cladding panels and insulation, inserted at top, bottom, edges and perimeters of penetrations.
  2. Opening Size: Sized to minimize infiltration of air, water, dust, and insects into the cavity space, and allowing drainage of water accumulating within ventilation cavity.
2. Fasteners: Stainless steel fasteners designed to reduce thermal conductivity and that accommodate thermal expansion and contraction without transferring excessive stress to cladding panels.
3. Structural Thermal Break Spacer: Fibre reinforced thermoset plastic, structural thermal break, washers, and bushings, custom sized to match structural bearing locations, and as follows:
  1. Loading Pressure: Nominal 300 N/mm<sup>2</sup>.
  2. Compressive Modulus: Nominal 10,000 N/mm<sup>2</sup>.
  3. Shear Strength: Nominal 110 N/mm<sup>2</sup>.
  4. Thermal Conductivity: Maximum USI-Value 0.20 W/m<sup>2</sup>-°K.
  5. Basis-of-Design Products: Armatherm FRR Structural Thermal Break by Armatherm.
4. Thermal Breaks and Separation Strips: EPDM rubber or cork strips as standard to thermally improved cladding support system, and to maintain performance required for thermal improvement indicated above.
5. Supporting Substructure and Girts: Manufacturer's standard system of substructure and girts, thickness based on structural support requirements of thermally improved cladding support system, and as follows:
  1. Steel Girts: Fabricate from galvanized zinc coated steel meeting requirements of ASTM A653/A653M having Grade A, Z275 Coating.
6. Finish: Black finished where visible through open joints of cladding system; bare metal in concealed locations and in closed joint systems.
7. Drainage and Air Circulation: Perforate or notch horizontal components to allow for drainage and airflow.
8. Girt locations as determined thermally improved cladding support manufacturer to align with modular panel fasteners spacing based on panel load data.

## 2.4 FABRICATION

1. Fabricate thermally improved cladding support systems to retain panels and other components to obtain profiles and details indicated on drawings and as indicated in shop drawings.
2. Fabricate components at factory to the greatest extent possible using best shop practices as required by panel manufacturer; fabricate components to match quality and installation of reviewed mock-up specified above.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.



### **3.2 INSTALLATION**

1. Install thermally improved cladding support systems in accordance with manufacturers written instructions, product data and reviewed shop drawings with completed installation secured, free of rattles, distortions, waviness, and protrusions, damaged or chipped components, and as follows:
  1. Install in proper relationship with adjacent materials.
  2. Use termination trims and closures at rough openings to properly transition and enclose wall assembly continuous insulation.

### **3.3 CLOSEOUT REQUIREMENTS**

1. Cleaning: Clean installed product in accordance with manufacturer's written recommendations.
2. Repairing: Touch-up, repair or replace damaged products before cladding installation through the date of Substantial Performance of the Work.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for aluminum composite wall panel assembly and forming an integrated rain screen assembly vented horizontally and vertically including, but not limited to, the following:
  1. Exterior Panel Cladding: Anchorages, shims, furring, fasteners, girts, flashings, adapters, insulation, air and vapour membrane, and closures.
  2. Accessory Cladding: Sills, borders and fillers integral to the panel system and required for a complete assembly.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Architectural Manufacturer's Association (AAMA)/Fenestration & Glazing Industry Alliance (FGIA):
  1. AAMA 508-21, \*Voluntary Test Method and Specification for Pressure Equalized Rainscreen Wall Cladding Systems
  2. AAMA 2605-22, \*Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix
3. American Society for Testing of Materials (ASTM):
  1. ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
  3. ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
4. Canadian General Standards Board (CGSB):
  1. CGSB 1.108-M89, Bituminous Solvent Type Paint
5. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S102:2019 (R2024), Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S134-13, Standard Method of Fire Test of Exterior Wall Assemblies

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meetings: Include required participants and an outline agenda for meeting in accordance with Section 01 31 19 – Project Meetings, and as follows:
  1. Meeting Time: Arrange meeting before starting work of this Section to discuss expectations for fit and finish of composite panel assemblies, quality of workmanship for installation of air and vapour retarders and transitions, continuity of insulation and relationship of panel system to adjacent components.
  2. Participants: Arrange for attendance by Contractor, Subcontractor for this Section; Subcontractor of affected components of the Work, manufacturer's representative and Consultant.

2. Coordination: Coordinate work of this Section with work of other sections that may have items supported by or built into composite panel assemblies including, but not limited to, supports and connectors to structure, doors and windows, mechanical and electrical penetrations, erection tolerances, and as follows:
  1. Flashings for Other Work of the Contract: Coordinate work of this section with requirements of Section 07 62 00 – Sheet Metal Flashing and Trim for supply of prefinished sheet metal flashing materials to other Sections of the Work with installation by other Sections of the Work as follows:
    1. Supply prefinished sheet metal flashings required for the project in sheet metal thickness and colour specified in this Section.
    2. Provide prefinished sheet metal flashings tension levelled, and guillotine sheared to length ready for brake forming, fabrication and installation.

### 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Shop Drawings: Submit shop drawings indicating attachment methods, joinery for joint layout, sealing methods and accommodation of thermal movement, drawing at a minimum half full size.
  2. Samples for Verification: Submit samples for verification by Consultant as follows:
    1. Panels: Submit two (2) 300 mm x 300 mm samples of selected colour.
    2. Accessories: Submit one (1) sample of clips, caps, battens, fasteners, closures, and other exposed panel accessories used in the final panel assembly.
3. Informational Submittals: Provide the following submittals when requested by the Consultant:
  1. Certificates: Submit qualification statement or certificate stating that fabricator and installer are approved by manufacturer and have the necessary tools, equipment and expertise to undertake work specified in this Section; include lists of completed projects with project names and addresses, names and addresses of consultants and owners indicating range of experience.
  2. Source Quality Control Submittals: Submit product test reports indicating compliance of manufactured panel assemblies and materials with performance and other requirements based on comprehensive testing of current products.
  3. Site Quality Control Submittals: Submit written inspection report indicating compliance with manufacturers requirements for installation and system requirements.
  4. Submit authorized documentation stating conformation to CAN/ULC S102, CAN/ULC S114, and CAN/ULC S134.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### 1.6 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit manufacturer's written instructions for cleaning procedures, include names of recommended cleaning agents and precautions against materials and methods detrimental to finishes and performance in accordance with Section 01 78 23 – Operation and Maintenance Data.

### 1.7 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Manufacturer: Use a manufacturer that has completed panel assemblies having similar extent and complexity as required for the Work of this Contract.

2. Installers: Use experienced installers having experience with panel projects similar in material, design and extent as required for Work of this Contract with a record of successful in-service performance.

### **1.8 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver panels and other components so they will not be damaged or deformed; package panels for protection against damage during transportation or handling.
2. Storage and Handling Requirements: Handling panels with care during unloading, storing, and erection to prevent bending, warping, twisting, and surface damage:
  1. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weather tight and ventilated covering.
  2. Store panels in dry location.
  3. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

### **1.9 SITE CONDITIONS**

1. Site Measurements: Verify locations of structural members and opening dimensions by site measurements before fabrication and indicate measurements on shop drawings for composite panel assemblies that are indicated to fit other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Established Dimensions: Establish dimensions and proceed with fabricating panel assemblies without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual site dimensions correspond to established dimensions; allow for trimming and fitting.

### **1.10 WARRANTY**

1. Manufacturer's Warranty: Provide manufacturer's standard five (5) year warranty against manufacturing and workmanship defects and ten (10) year warranty covering failure of factory-applied exterior finish on aluminum composite wall panels within the specified warranty period.

## **2 Products**

### **2.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. 3A Composites USA Inc., Alucobond.
  2. Alcotex Inc.
  3. Aflrex.
  4. Alpolc Materials, Mitsubishi Chemical.
  5. Elemex, Aluminum Composite.
  6. Larson Alucoil North America.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### **2.2 PERFORMANCE REQUIREMENTS**

1. Regulatory Requirements: Provide panels that are listed and labelled in accordance with CAN/ULC S102 and CAN/ULC S134 for fire endurance and flame spread testing.

2. System Description: Plans, elevations, details, characteristics, and other requirements indicated are based upon materials and details provided by one manufacturer that forms products named in this Section and as follows:
  1. Responsibility: Delegated Design professional engineer is responsible for designing composite panel assembly, composite panel thickness and connections based on design loads, and verifying that installation meets requirements of the Authority Having Jurisdiction.
  2. Provide a rear ventilated rain screen system in accordance with good design practices as established by Canada Mortgage and Housing Corporation for Composite panel assemblies.
  3. Provide a system that has no visible fasteners, telegraphing or fastening on the exposed panel faces or other components that detract from a neat and flat finished appearance.
  4. Provide a system that does not place restraints on panel that could result in compressive skin stresses, and that will maintain a flat appearance regardless of temperature change.
3. Design fabricated panel assemblies to meet or exceed the following minimum requirements:
  1. Wind Load: 0.45 kPa 1/50-year occurrence in accordance with the Building Code for deflection and strength, modified by the appropriate exposure, gust and pressure (internal and external) factors in accordance with Building Code structural commentaries
  2. Deflection Limitation: Maximum deflection of perimeter not to exceed  $L/175$ ; whichever is less, under system weight plus wind load (positive and negative) loads acting normal to plane of installation under 1 in 50-year sustained wind loading, and as follows:
    1. Maximum deflection criteria apply to horizontal plane of system, width and length, as well as vertical deflection.
    2. Include adequate stiffeners and fasteners are included to prevent excessive deflection.
4. Thermal Movement: Design system that allows for thermal movements without buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects resulting from the following maximum change in ambient and surface temperatures:
  1. Base design calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
  2. Temperature Range:
    1. Ambient Conditions: 65°C
    2. Surface Conditions: 100°C
    3. Operating Range: -32°C to +55°C
5. Building Movement: Include provisions to accommodate movement in composite panel system and between composite panel system and building structure where these movements are caused by deflection of building structure.
6. Drainage: Provide for positive drainage to the exterior of all water entering or condensation occurring within the system in accordance with NRC Rain Screen Principles.

### 2.3 ALUMINUM COMPOSITE WALL PANELS

1. Aluminum Composite Wall Panels: Two sheets of prefinished AA3000 or AA5000 Series aluminum sandwiching a fire rated composite core, formed in a continuous process with no glues or adhesives between dissimilar materials, and as follows:
  1. Total Composite Thickness: 4 mm.
  2. Core: Non-combustible in accordance with ASTM D1929, CAN/ULC S102 and CAN/ULC S134.
  3. Face Sheets: Nominal 0.50 mm thick.

4. Finish: Finished using heat cured coating system composed of specially formulated inhibitive primer, fluoropolymer colour coat, and clear alkyl ether resin; coil coated with Kynar 500 or Hylar 5000 based Polyvinylidene Fluoride (PVDF) or Fluoro Ethylene-Alkyl Vinyl Ether (FEVE) resin in accordance with AAMA 2605 coating thicknesses as follows:
  1. Colour: Colour selected by Consultant from manufacturer's standard range.
2. System Back-Up Materials:
  1. Girts: Fabricated from minimum 1.27 mm thickness galvanized steel to ASTM A653/A653M, Grade 230 with Z275 coating; finish material visible after assembly of panel to match panels.
  2. Sub-Girts: Structural quality steel to ASTM A653/A653M, with Z275 zinc coating to ASTM A792/A792M, adjustable double-angle profile as indicated to accept panel with structural attachment to building frame.
  3. Isolation Tape: Manufacturers standard material for separating dissimilar metals from direct contact.
3. Air Barrier Membrane: Refer to Section 07 27 16 – Air Barrier Membrane.
4. Insulation: Refer to Section 07 21 13 – Board Insulation.
5. Insulation Fastenings: Corrosion resistant, galvanized bugle head screws with 38 mm diameter washer, 25 mm minimum penetration into framing.
6. Accessories: Provide fasteners, gaskets and other materials necessary for a complete installation including the following:
  1. Extrusions: Formed aluminum members, sheet, and plate in accordance with ASTM B209/B209M and manufacturers written recommendations and as follows:
    1. Perimeter Extrusions: Alloy: AA-6063-T5 or AA-6063-T6, mill finish where non-exposed; to match panels when exposed.
    2. Stiffeners: Alloy: AA-6063-T5 or AA-6063-T6, mill finish
  2. Panel Stiffeners: Structurally fastened or restrained at ends, secured to rear face of composite panel with silicone or double-sided high bond isolating tape to prevent weather staining and frost lines to the face of the panel as recommend by panel manufacturer; size stiffeners to maintain panel flatness to specified tolerances; material as recommended by panel manufacturer.
  3. Sealants and Gaskets: Panel system components as recommended by panel manufacturer to meet performance requirements.
  4. Flashings: Where flashing is not indicated as composite panel material, fabricate flashing from 0.75 mm minimum thickness stainless steel sheet, to match panel where exposed to view; provide lap strip under flashing at butted conditions, with lapped surfaces sealed in a full bed of non-hardening sealant.
  5. Fasteners: Non-corrosive fasteners as recommend by panel manufacturer, and as follows:
    1. Attachment panel system to primary panel structural supports using manufacturer's recommended concealed fasteners.
    2. Use concealed fasteners for typical joinery.
    3. Obtain Consultant's acceptance where exposed fasteners are required in isolated conditions; Consultant will permit a limited number of exposed fasteners obscured within panel joinery using stainless steel fastenings, or in the face of panels using colour matched fastenings.

## 2.4 FABRICATION

1. Fabricate composite panels and components to obtain profiles and details indicated on drawings and as indicated in shop drawings.
2. Fabricate components at factory to the greatest extent possible using best shop practices as

### 3 Execution

#### 3.1 PREPARATION AND EXAMINATION

1. Obtain dimensions from Design Model before fabricating wall system.
2. Verify that building surfaces are smooth, clean and dry, and free from defects detrimental to the installation of the system.
3. Notify ~~Consultant any Contractor of~~ conditions not acceptable for installation of system, start of work will indicate acceptance of substrate conditions.
4. Inspect all panels and components prior to installation and verify that there is no shipping damage; do not install damaged panels, repair or replace as required for smooth and consistent finished appearance.

#### 3.2 INSTALLATION

1. Install air barrier membrane in accordance with Section 07 27 16 – Air Barrier Membrane.
2. Install board insulation in accordance with Section 07 21 13 – Board Insulation.
3. Install girts in accordance with manufacturer's instructions. Provide additional metal framing as may be required to conform to Performance Requirements.
4. Install girts attached to structural support or framing, using recommended fasteners.
5. Install aluminum through wall flashing (fire break) as detailed on Drawings.
6. Install insulation between girts forming tight to following applied girt to maintain continuous thermal barrier. Install insulation with disk type fasteners spaced at 305 mm vertical o/c spaced evenly from edges of insulation, and at 406 mm horizontal O/C.
7. Install fasteners into framing; do not remove fastener where fastener does not penetrate framing; removal of fastener will damage integrity of air/vapour membrane, realign fastener location and install new fastener in close proximity to original fastener so that it penetrates framing.
8. Install flashings to divert all moisture and condensation to exterior. Trim and flash around doors, louvers, and windows.
9. Install exterior metal cladding to structural support by hidden mechanical fasteners.
10. Apply bituminous paint or caulking tape to insulate between the dissimilar materials and aluminum materials. Factory applied protective paint or G-90 galvanized steel is considered adequate insulation.
11. Install pre-formed corners and end enclosures, sealed to arrest direct weather penetration.
12. Install panels are aligned vertically and horizontally, and flush between adjacent panels to within tolerances indicated; with weep holes and drainage channels free of dirt and sealants that could impede the function of the rain screen assembly.
13. Assemble and secure panel system so stresses on sealants are within manufacturers' recommended limits.
14. Tolerances:
  1. Panel Dimensions: Allow for site adjustment and thermal movement.
  2. Panel Fabrication: Fabricate panels under controlled shop conditions to the greatest extent possible; site fabrication will only be permitted where minor adjustments are required to account for substrate variations that could not be identified during the preparation of shop drawings.
  3. Panel Lines, Breaks and Curves: Form changes in direction sharp, smooth, and free of warps or buckles.
  4. Panel Surfaces: Free of scratches or marks caused during fabrication and installation.

5. Panel Bow: Maximum 0.8% of any 1830 mm panel overall dimension in width or length.
6. Panel Flatness: Maximum 3 mm in 1525 mm deviation from panel flatness non-cumulative; no oil canning.
7. Panel Joints: Maximum 1 mm lippage between any 2 adjacent panels not attached with same fastener; 0 mm lippage where 2 adjacent panels share the same fastener.

### 3.3 SITE QUALITY CONTROL

1. Perform final inspection of completed work with manufacturer's representative in attendance; manufacturer's representative shall prepare a written report and submit to Consultant certifying that installation meets manufacturer's requirements and detailing for systems described in this Section.
2. Perform final inspection with Consultant, Contractor and Subcontractor, present; provide a minimum of 72 hours' notice so that all parties can confirm their attendance.

### 3.4 CLOSEOUT ACTIVITIES

1. Repairing:
  1. Remove and replace panels that are damaged and cannot be repaired; coordinate with Contractor for responsibility of repairs not caused by work of this Section.
  2. Touch-up damaged finishes with manufacturer's recommended touch-up paint.
2. Cleaning:
  1. Remove strippable film coating or masking as soon as possible (or as co-ordinated by Contractor) after surrounding material is installed.
  2. Remove excess materials, debris, and equipment at completion.
  3. Clean all panels clean and free of all grime and dirt.

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. This Section specified requirements for the supply and installation of aluminum siding and soffit including accessories and trims for a complete system installation.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. American Architectural Manufacturers Association (AAMA)/Fenestration & Glazing Industry Alliance (FGIA):
  1. AAMA 509-22, \* Voluntary Test and Classification Method for Drained and Back Ventilated Rainscreen Wall Cladding Systems
  2. AAMA 2603-22, \*Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)
  3. AAMA 2604-22, \*Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)
  4. AAMA 2605-22, \*Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)
2. American Society for Testing and Materials International (ASTM International):
  1. ASTM E84-24, Standard Test Method for Surface Burning Characteristics of Buildings Materials
  2. ASTM E136-24c, Standard Test Method for Behaviour of Materials in a Vertical Tube Furnance at 750°C
  3. ASTM E2768-11(2018), Standard Test Method for Extended Duration Surface Burning Characteristics for Building Materials (30 min Tunnel Test)
3. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S114:2018, Standard Test Method for Determination of Non-Combustibility in Building Materials
  3. CAN/ULC-S135-04, Standard Test Method for the Determination of Combustibility Parameters of Building Materials Using an Oxygen Consumption Calorimeter (Cone Calorimeter).

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meetings: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to aluminum siding and soffit installation requirements and coordination with other work of the project.
2. Coordination: Coordinate installation with flashing and other adjoining construction to ensure proper sequencing.

## **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's product data for each type of product specified.
  2. Shop Drawings: Submit shop drawings showing assembly and installation details, method of sealing and flashing, building connection attachments, provision for thermal movement, fabrication details and static release loads and static release forces.
  3. Samples for Verification: Submit samples for verification for each type, colour, texture, and pattern required, and as follows:
    1. Siding and Soffit: 300 mm long by actual width.
    2. Accessories and Trims: 300 mm long by actual width.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

## **1.7 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Source Limitations: Obtain each type, color, texture, and pattern of aluminum siding and soffit, including related accessories, through one source from a single manufacturer.

## **1.8 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver packaged materials in original containers with labels intact until time of use.
2. Storage and Handling Requirements: Store materials on elevated platforms, under cover, and in a dry location.

## **1.9 SITE CONDITIONS**

1. Ambient Conditions: Proceed with siding installation only if substrate is completely dry and if existing and forecasted weather conditions permit siding to be installed in accordance with manufacturer's written instructions.

## **1.10 WARRANTY**

1. Manufacturer's Warranty: Warranty: Provide manufacturer's standard fifteen (15) years warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

# **2 Products**

## **2.1 MANUFACTURERS**

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.

2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. AL13 Architectural Systems.
  2. Luxyclad.
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## **2.2 PERFORMANCE REQUIREMENTS**

1. Design and construct soffit system so that completed installation is air, vapour and moisture resisting from interior and exterior.
2. Maximum deflection not to exceed L/180 under system own weight plus wind and suction loads acting normal to the plane in accordance with the Building Code Climatic Data, wind load 1:50 years.
3. Provide movement of components without causing buckling, failure of joint seals, undue stress on fasteners when subject to seasonal temperature range, from - 40°C to +50°C, and preceding noted wind and suction loads.
4. Include expansion joints to accommodate movement in soffit system and between soffit system and building structure, where these movements are caused by deflection of building structure. Accommodate these movements, without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
5. Provide for positive drainage to the exterior of all water entering or condensation occurring within the system.

## **2.3 MATERIALS**

1. Extruded Aluminum Siding and Soffit: V-Groove planks extruded aluminum 6063 T5, and as follows:
  1. Finish: Woodgrain finish.
  2. Colour: Colour selected by Consultant from manufacturer's standard range.
  3. Gloss: 30 ± 5.
  4. Thickness: 1.57 mm base metal thickness.
  5. Profile: Nominal 100 mm V-Groove X 7315 mm plank.
  6. Basis-of-Design Products: Longboard Architectural Products, Smooth Plank.

## **2.4 ACCESSORIES**

1. Girts, Hat Channel, and Z-Bars: Minimum 18 ga. spaced at 406 mm o/c.
2. Siding Accessories: Provide starter strips, edge trim, corner cap, and other items as required by aluminum siding and soffit manufacturer for building configuration in accordance with AAMA 1402, and as follows:
  1. Provide accessories made from same material as adjacent siding, unless noted otherwise.
  2. Provide accessories matching color and texture of adjacent siding, unless noted otherwise.
3. Flashing: Provide metal flashings as specified in Section 07 62 00 – Sheet Metal Flashing and Trim at window and door heads and where indicated.
4. Elastomeric Joint Sealant: Single component urethane joint sealant in accordance with Section 07 92 00 – Joint Sealants.

5. Fasteners: Use manufacturer's recommended aluminum fasteners. Where fasteners are exposed to view, use prefinished aluminum fasteners in colour to match items being fastened.
6. Insect Screening: 1.4 mm x 1.6 mm aluminum wire mesh.

## **2.5 FABRICATION**

1. Prepare surfaces, pre-treat and coat components in accordance with AAMA 2604 and AAMA 2605 Quality Standards and applicable standards for the coating material specified.
2. Wrap and package coated components using methods suitable for transit and covered site storage without damage.

## **3 Execution**

### **3.1 EXAMINATION**

1. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of siding; proceed with installation only after unsatisfactory conditions are corrected.

### **3.2 PREPARATION**

1. Clean substrates of projections and substances detrimental to application.

### **3.3 INSTALLATION**

1. Install aluminum siding and soffit in accordance with manufacturer's written installation instructions and reviewed shop drawings and as applicable to products and applications indicated unless more stringent requirements apply, and as follows:
  1. Center concealed fasteners without binding siding to allow for thermal movement.
  2. Overlap joints to shed water away from direction of prevailing wind.
2. Install joint sealants as specified in Section 07 92 00 – Joint Sealants to provide a weathertight installation.
3. Where aluminum siding contacts dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

### **3.4 CLOSEOUT ACTIVITIES**

1. Repairing: Remove damaged, improperly installed, or otherwise defective siding materials and replace with new materials in accordance with specified requirements.
2. Cleaning: Clean finished surfaces in accordance with manufacturer's written instructions and maintain in a clean condition during construction.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of SBS modified bituminous membrane roofing system, LEED v4.1 compliant, consisting of two (2) ply roofing membrane with mopped base sheet and torch applied cap sheet, flat and sloped insulation board, vapour barrier adhered to gypsum board sheathing on steel deck.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. American Society for Testing Materials (ASTM International):
  1. ASTM C1177/C1177M-17, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
  2. ASTM C1278/C1278M-17, Standard Specification for Fiber-Reinforced Gypsum Panel
  3. ASTM D3273-21, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in and Environmental Chamber
  4. ASTM E96/E96M-22, Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
2. Canadian Standards Association (CSA Group):
  1. CAN/CSA A123.4-04 (R2018), Bitumen for Use in Construction of Built-up Roof Coverings and Dampproofing and Waterproofing Systems
  2. CSA A123.21:20, Standard Test Method for the Dynamic Wind Uplift Resistance of Mechanically Attached Membrane-Roofing Systems
  3. CSA A123.23-15 (R2020), Product Specification for Polymer-Modified Bitumen Sheet, Prefabricated and Reinforced
  4. CSA B111-1974 (R2003), Wires, Nails, Spikes and Staples
  5. CSA O121-17, Douglas Fir Plywood
  6. CSA O151-17, Canadian Softwood Plywood
3. Roofing Association Publications:
  1. Canadian Roofing Contractors Association (CRCA): Canadian Roofing Reference Manual
4. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S107:2019, Standard Methods of Fire Tests of Roof Coverings
  3. CAN/ULC S704.1:2022A, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Arrange a pre-construction meeting in accordance with Section 01 31 19 – Project Meetings, attended by the Contractor, Subcontractor, roofing manufacturer's representative, Consultant, and Owner to review installation conditions particular to this projects including, but not limited to, review of structural load limitation of roof deck during and after roofing installation, review of flashing, special roofing details, roof drainage, roof penetrations, equipment curbs, and conditions of adjacent construction that affect roofing.
2. Coordination:
  1. Coordinate placement of acoustical insulation in steel deck flutes at locations where acoustical assemblies abut metal steel deck immediately prior to roofing installation.

2. Coordinate compatibility of materials and confirm that roofing membrane materials are compatible with specified air barrier membranes.

### 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit electronic copies of membrane manufacturers current technical data sheets describing the physical properties and recommended installation procedures, limitations and other manufacturer recommendations.
  2. Shop Drawings:
    1. Submit sloped insulation manufacturer's proposed roofing diagrams and layouts for review by the Consultant.
    2. Submit membrane manufacturer's standard details that will be used for this project, indicate changes that must be made to make the details project specific for review by the Consultant.
3. Informational Submittals:
  1. Wind Uplift Resistance Report: Submit manufacturer's written report certifying that roofing system materials were tested in accordance with CSA A123.21 and state compliance with sustained wind uplift pressures described in this Specification.
  2. Declaration of Whole Building Enclosure Materials Compatibility: Submit written declaration indicating that roofing system materials are compatible with transition membranes, weather barriers, and air and vapour membranes specified for adjacent building enclosure components that are in contact with roofing materials.
  3. Site Quality Control Submittal: Submit certification indicating that components used in the roofing system are supplied and warranted by a single source manufacturer.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### 1.6 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.

### 1.7 QUALITY ASSURANCE

1. Use the Roofing Application Standards Manual as published by Canadian Roofing Contractors Association (CRCA) as reference for installation and best practices.
2. Execute work by an installer approved by the CRCA as a member in good standing during the execution of Work.
3. Installer must maintain a full-time experienced journeyman roofer, and at least one apprentice per crew on the Work at all times, and as follows:
  1. Subcontractor and his sub-subcontractors must have "Approved Contractor" status by the roofing product manufacturer. Only skilled and certified trade persons, officially employed by a roofing Subcontractor operating adequate and necessary equipment, must be authorized to perform all roofing work.
  2. Crew members using torches must be trained under a recognized training program and certified from the manufacturer of materials being installed. Only competent, qualified tradesmen, using adequate plant and equipment, must execute the Work of this Section.
4. Obtain roofing membrane materials through one source from a single manufacturer and install using workers who are trained and approved by the roofing membrane manufacturer.

## 1.8 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver materials to the project site, handle and store in original packages and containers with manufacturer's seals and labels intact. Manufacturer's name, brand, mass, specification number and lot number must be shown on the labels.
2. Storage and Handling Requirements:
  1. Store materials in weatherproof shelters having floors that will protect the materials from moisture. Store materials on end. Avoid prolonged exposure of light or heat sensitive materials to sunlight.
  2. Do not store materials on roof in concentrations that exceed design live load.
  3. Place plywood runways over the Work to enable the movement of materials and other traffic during construction of roofing.
  4. Protect surrounding surfaces against damage from roofing work. Where hoisting is necessary, hang tarpaulins to protect walls during delivery of materials from ground to roof.
  5. In the event of materials damage by the elements, improper handling or other causes, such materials will be rejected and will be replaced at no extra cost to the Owner. Remove rejected materials promptly from the site.
  6. During roofing work, exposed surfaces of finished walls must be protected with tarp to prevent damage. Assume full responsibility for damage.

## 1.9 SITE CONDITIONS

1. Ambient Conditions: Minimum ambient application temperature shall not be less than -23°C. Notify Consultant where installation is required below stated minimum temperature and submit manufacturer's standard cold weather installation practices prior to proceeding with work of this section.

## 1.10 WARRANTY

1. Manufacturer's Warranty: Provide manufacturer's warranty stating that they will repair or replace defective roofing (including labour) and base flashing materials that do not remain watertight, that splits, tears, or separates at the seams or from the substrate within the specified warranty period, and as follows:
  1. Warranty Period: Ten (10) years, Standard Warranty, starting from Substantial Performance.
  2. Name of Warrantee: Warrantor shall issue a written and signed warranty identifying the owner's name as the warrantee and stating that executed work will remain in place and be free of any defects in materials and workmanship for the stated warranty period.

## 2 Products

### 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. IKO Industries Ltd.
  2. Henry Company.
  3. Siplast.

3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Regulatory Requirements: Perform roofing and sheet metal work in conformance with the roofing manufacturer's written recommendations using materials that meet the requirements of CAN/ULC S107 to obtain a Class A fire resistance rating, submit proof that roofing materials meet required performance when requested by Consultant.
2. Fire Protection:
  1. Protect roof junctions at parapets, roof curbs and upstands with a fire-resistant tape or barrier to prevent combustible materials within assemblies from ignition arising from the use of torches. Install prior to installation of base sheets.
  2. Use a heat detector gun to spot any smouldering or concealed fire at the end of each workday. Establish a minimum one-hour fire watch after torch application.
  3. Do not apply torch directly to dry or unprotected wood surfaces.
  4. Maintain a clean site and have one approved ABC fire extinguisher within 6 meters of each roofing torch. Respect all safety measures described in manufacturer's technical data sheets. Do not place torches near combustible or flammable products.
3. Wind Uplift Performance: Provide roofing systems that meet wind uplift performance requirements for conventional roofing assemblies in accordance with CSA A123.21 for wind loads based on 1/50-year occurrence as indicated in the Building Code, and as follows:
  1. Wind Loads: Based on 1/50-year occurrence as follows:  
Corners: -2.5 kPa  
Edges: -1.3 kPa  
Field: -1.0 kPa
  2. Building Geometry: Low Rise, based on building height, width and length indicated on Drawings, and having parapets 200 mm high or less.
  3. Building Exposure: Rough Terrain.
  4. Building Openings: Category 2.
  5. Building Importance: Normal.

## 2.3 MATERIALS

1. Oxidized asphalt: in conformance with CAN/CSA A123.4, and as follows:
  1. Type 2 oxidized asphalt for slopes  $\leq 2\%$ .
  2. Type 3 oxidized asphalt for slopes between 2% and 25%.
2. Adhesives:
  1. Membrane Roofing Materials Adhesive: Cold adhesive-mastic composed of a bituminous binder, added to bonding agents and solvents compatible with specified roofing products.
  2. Insulation Adhesive: Manufacturers standard adhesives specifically formulated for installation of plastic insulation to roofing materials:
    1. Basis-of-Design Products: Soprema Canada, Duotack Adhesive.
  3. Gypsum Board Adhesive: Manufacturers standard adhesives specifically formulated for installation of gypsum board to metal deck.



3. Auxiliary Levelling Surface:
  1. Fibre-Reinforced Gypsum Sheathing: Non-Structural, fibre-reinforced gypsum sheathing manufactured in accordance with ASTM C1278/C1278M and ASTM D3273, having a homogenous composition for panel strength, water, mold resistance, ready for vapour retarder as specified in this Section, and as follows:
    1. Thickness: 12.7 mm.
    2. Surface Burning Characteristics: In accordance with CAN/ULC S102.
    3. Long Edges: Square.
    4. Locations: Installation over steel decks and sheathing for parapets.
    5. Basis-of-Design Products: CGC, Securock Brand Gypsum-Fiber Roof Boards.
4. Vapour Barrier Membrane:
  1. Vapour Barrier Membrane: SBS Modified bituminous self-adhesive membrane, with a surface screen made of high-density polyethylene laminated between two layers of polyethylene films, and as follows:
    1. Membrane Width: Nominal membrane width of 1000 mm.
    2. Adhesion Surface: Self-adhesive under face protected with a silicone plastic release film. Performance as follows:
    3. Water Vapour Transmission: Maximum 2.8 ng/Pa·s·m<sup>2</sup> in accordance with ASTM E96/E96M, Procedure B.
    4. Basis-of-Design Products: Soprema Canada, Soprapap'R.
  2. Vapour Barrier Continuity Strip: SBS membrane with non-woven polyester reinforcement, glass grid and elastomeric bitumen. Sanded upper surface, underside self-adhesive, compatible with wall and roof air barrier membranes.
5. Carpentry:
  1. Wood roof materials shall be as specified in Section 06 10 53 – Miscellaneous Rough Carpentry. DO NOT use pressure treated materials where SBS membrane materials are adhered to wood fabrications.
6. Insulation:
  1. Primary Flat and Sloped Insulation: Polyisocyanurate foam rigid board roof insulation, of largest panels practical, having square edges, minimum LTTR RSI 0.99/25 mm, total thickness as indicated on Drawings, sloped to a minimum 2% perpendicular from edge of roof to a minimum thickness as indicated on Drawings; conforming to CAN/ULC S704.1, Type 3, Class 2, to a tolerance not exceeding 3 mm from nominal size in any dimension, and as follows:
    1. Basis-of-Design Products: Soprema Canada, Sopra-Iso Plus.
7. Cover Board – Membrane Underlayment:
  1. Cover Board for Roof Slopes less than 6%: Fibreglass mat faced gypsum board conforming to ASTM C1177/C1177M, enhanced moisture and mould resistant, having a non-combustible core, primed ready for torched application of SBS base sheets.
8. Fasteners:
  1. Roofing fasteners to steel decking: Cadmium plated flat headed, self-tapping screws, No. 12 of Type A or AB, in conformance with CSA B35.3.
  2. Insulation fasteners to decking: Screws and stress plates, galvanized steel, minimum 50 mm diameter spaced one per 0.25 m<sup>2</sup>, penetrating a minimum of 38 mm into top of flutes for corrosion and wind lift factors.

9. Perimeter Fire Seal:
  1. Self-Adhering Fire Seal: SBS modified bitumen, minimum 60 gm/m<sup>2</sup> glass fleece reinforced, self-adhering membrane having sanded top face, cut into strips minimum 150 mm wide x nominal 1.5 mm thick, and as follows:
    1. Basis-of-Design Products: Soprema Canada, Sopraguard Tape.
10. Roof Membrane Base Sheets:
  1. Membrane for mopped application, for use with roof slopes less than 6%:
    1. Roofing membrane with non-woven polyester reinforcement and elastomeric bitumen, top face covered with thermofusible plastic film, underside sanded in accordance with CSA A123.23, Type B, Grade 3, and as follows:
      1. Basis-of-Design Products: Soprema Canada, Elastophene 180 PS.
11. Membrane Base Sheet Flashing:
  1. Primer: Manufacturer's recommended elastomeric bitumen or synthetic rubber blend, volatile solvents, adhesive enhancing additives and resins used to prime substrate to enhance the adhesion of self-adhesive membranes suitable for application temperatures.
  2. Roofing membrane with non-woven polyester reinforcement and glass grid and elastomeric bitumen. Top face covered with thermofusible plastic film, underside self-adhesive and protected by silicone release paper in accordance with CSA A123.23, Type C, Grade 3, and as follows:
    1. Basis-of-Design Products: Soprema Canada, Sopraply Flam Stick.
12. Roof Membrane Cap Sheets:
  1. Roofing membrane with non-woven polyester reinforcement and elastomeric bitumen with flame-retarding agent. Top face protected by coloured granules, meeting LEED v4.1 SRI, ULC Class A, underside covered with a thermofusible plastic film in accordance with CSA A123.23, Type C, Grade 1, and as follows:
    1. Basis-of-Design Products: Soprema Canada, Soprastar FR GR.
13. Flashing and Sheet Metal:
  1. Hot-dipped galvanized steel, prefinished of colour selected by Consultant and as specified in Section 07 62 00 – Sheet Metal Flashing and Trim.
  2. Liquid Applied Flashing: Two-component liquid applied membrane flashing composed of polymethyl methacrylate (PMMA) with reinforcement, and as follows:
    1. Basis-of-Design Products: Soprema Canada, Alsan RS 260 Lo Field.

## 2.4 ACCESSORIES

1. Pipe Supports: Premanufactured Pipe Supports: Premanufactured pipe supports fabricated from 100% recycled rubber, with 2.7 mm thickness galvanized steel frame, 150 mm wide x 100 mm tall x length to suit installation; including fasteners, bridge components, and angled supports as required for a complete installation and having the following accessories:
  1. Pipe and Conduit Support: Galvanized pipe clamp sized to suit gas pipe in accordance with manufacturers instructions.
  2. Multi-Pipe and Conduit Support: Galvanized pipe support system size and number to suit pipes being supported in accordance with manufacturer's instructions.
  3. Extendable Height Support: Galvanized steel pipe extensions to suit installation in accordance with manufacturer's instructions.
  4. Basis-of-Design Products: Clearline Technologies, C-Port.
2. Bituminous Primer: Asphaltic, and compatible with SBS modified bituminous membrane, and as follows:

1. Basis-of-Design Products: Soprema Canada, Elastocol 500.
3. Traffic Course: Roofing membrane with non-woven polyester reinforcement and elastomeric bitumen with flame-retarding agent. Top face protected by coloured granules, ULC Class A, underside covered with a thermofusible plastic film, in accordance with CSA A123.23, Type B, Grade 1, and as follows:
  1. Basis-of-Design Products: Soprema Canada, Soprawalk.
4. Roof Drains: Refer to Division 22 – Plumbing.
5. Pressure sensitive tape: 50 mm wide self-adhering.

### 3 Execution

#### 3.1 EXAMINATION

1. Confirm that surfaces are acceptable for installation of roofing system before starting work of this Section:
  1. Confirm that deck conditions; slopes and wood blocking; including, but not limited to, upstands and parapets; construction joints, roof drains, plumbing vents, ventilation outlets and other penetrations are complete.
  2. Notify Contractor of conditions that do not conform to manufacturer's requirements; providing a list, so that required corrections can be made prior to start of the work.
  3. Installation of products specified in this Section will denote acceptance of site conditions.
  4. Start work when surfaces are smooth, dry, and free of ice and debris, and that are not contaminated with calcium or salt, ice, or snow melt products.

#### 3.2 PREPARATION

1. Start work of this Section when plumbing, electrical, carpentry and other related work is complete.
2. Protection of Adjacent Surfaces during Construction: Protect surrounding surfaces against damage from roofing work, and as follows:
  1. Subcontractor is responsible for repairing or replacing materials damaged during installation of roofing Products specified in this Section.
  2. Hang tarps to protect walls during delivery of materials from ground to roof where hoisting is necessary.
  3. Provide temporary plywood runways, of sufficient thickness to protect the Work and to facilitate the movement of materials and accommodate other traffic during construction of roofing.
  4. Weather Protection during Installation: Install roofing materials during conditions that do not add moisture to the assembled components; protect internal roofing components from wetting arising from rain or snowfall until membranes are complete.
3. Fire Protection during Installation: Protect roofing installation using experienced fire watch crew, following manufacturer's written torching procedures, and as follows:
  1. Protect roof junctions at parapets, roof curbs and upstands with a fire-resistant tape or barrier to prevent combustible materials within assemblies from ignition arising from the use of torches before starting installation of base sheets.
  2. Use a heat detector gun to spot any smouldering or concealed fire at the end of each workday.
  3. Establish a minimum one-hour fire watch after torch application.
  4. Use methods that prevent torching directly to dry or unprotected wood surfaces and combustible materials.
  5. Remove scrap wood and combustible materials from area of work.
  6. Provide one approved Type ABC fire extinguisher within 6 meters of roofing torches, with one extinguisher for each roofing torch.

4. Membrane Protection during Installation: Protect finished work to prevent damage to completed portions of the roof, and as follows:
  1. Provide temporary plywood runways, of sufficient thickness to protect the Work and to facilitate the movement of materials and accommodate other traffic during construction of roofing.
  2. Install protective boardwalks over installed roofing materials to enable passage of people and material.
5. Repair damage arising from work of this Section.
6. Acoustical Decking Insulation: Install acoustical insulation in deck flutes as indicated in Division 05 – Metals before installing roofing as specified.

### 3.3 INSTALLATION

1. Install roofing on clean and dry surfaces, in accordance with manufacturer's written instructions, and accounting for site conditions affecting installation.
2. Gypsum Board Installation on Steel Deck: At Contractor's choice, either mechanically fasten or adhere gypsum board levelling surface to into upper rib surfaces in accordance with CSA A123.21 tested assembly to achieve specified wind uplift resistance in each roof zone (field area, perimeter, and corners), and as follows:
  1. Cut boards so edges rest on centre of upper ribs.
  2. Cut boards to achieve straight lines free from burrs and tears using sharp tools.
  3. Cut boards at an angle where slopes change directions; breaking boards along the valley will not be permitted, cut boards cleanly.
  4. Place boards perpendicular to deck ribs for continuous support along edges.
  5. Stagger and offset board joints to align with adjacent boards and to butt against end joints.
3. Vapour Barrier Membrane Installation: Install self-adhesive, premanufactured vapour barrier membrane directly to the steel deck in accordance with manufacturer's written instructions and as follows:
  1. Align roll parallel to steel deck corrugations with membrane overlaps supported along entire length on top of flute.
  2. Cut off rolls and restart membranes that do not properly align with deck corrugations; adjustment of membrane by straightening or debonding/relaying will not be permitted.
  3. Overlap adjacent membranes, ends and staggers in accordance with manufacturer's instructions.
  4. Place thin sheet of metal under vapour barrier membrane to fully support end laps.
  5. Overlap roof vapour barrier to wall air/vapour barrier membranes using compatible continuity strip to provide continuous building enclosure.
  6. Seal vapour barrier membranes to components penetrating roof system in accordance with manufacturer's written instructions to maintain continuous building enclosure.
4. Insulation Installation: Install insulation in accordance with manufacturer's recommendations for wind uplift criteria for building type, height, and geographic location, at choice of Contractor, either mechanically fastened or adhered, as follows:
  1. Mechanical Attachment: Fasten insulation into top flutes of steel deck in quantity and pattern in accordance with CSA A123.21 tested assembly, and manufacturer's written recommendations, and as follows:
    1. Fasteners must be attached to steel deck's upper flutes.
    2. Stagger vertical joints between primary insulation boards and secondary insulation modules and between two rows of insulation board.
    3. Install only as much insulation as can be covered by roof membranes in the same day.

2. Adhered Attachment: In accordance with the pattern listed for the CSA A123.21 tested assembly, and manufacturer's written recommendations, and as follows:
  1. Stagger vertical joints between primary insulation boards and secondary insulation modules and between two rows of insulation board; and
  2. Adhere insulation at locations where roof deck will be visible in final installation; do not mechanically attach insulation where roof deck will be visible in final installation.
  3. Joint Alignment: Offset and stagger vertical joints between flat board insulation and sloped insulation modules, and between two layers of flat board insulation.
5. Cover Board Installation: Apply fasteners or adhesive in accordance with the CSA A123.21 tested assembly required to achieve the specified wind uplift resistance, and as follows:
  1. For roofs with slopes less than 6%, apply hot asphalt at a minimum rate of 1 kg/m<sup>2</sup>, following methods and temperatures recommended by insulation manufacturer and the ARCA to underside of membrane underlayment boards. Once asphalt has cooled but is still hot enough for good adherence without burning, install boards on primary insulation.
  2. For slopes greater than or equal to 6%, use mechanical fasteners at base of slopes and horizontally across the slope at maximum 10 metre intervals and as follows:
  3. Install fasteners so that they hold down insulation and membrane.
  4. Roof slopes will not exceed 9% in this project.
  5. Fasteners must penetrate the top flute of the steel deck.
  6. Tightly abut edges of cover boards, long joints continuous and short joints staggered, with joints offset from primary insulation joints.
  7. Apply only as many boards as can be covered by roofing membrane in the same day.
  8. Cut out a 10 mm slope in a 610 mm radius around drains.
6. Perimeter Fire Seal Installation: Apply self-adhering perimeter fire seal directly to perimeter and curb substrates prior to application of base sheet materials, to vertical joints in parapet or curb sheathing, and at vertical corners, and as follows:
  1. Extend material up face of parapet and onto decking substrate, overlapping side and end laps in accordance with manufacturer's written installation instructions.
  2. Use hand roller to remove air bubbles, wrinkles, and fish mouths; and
  3. Install perimeter fire seal to act as temporary moisture seal until installation of flashing materials.
7. Roofing Membrane Base Sheet Installation: Prime cover board in accordance with manufacturer's written instructions and materials, and as follows:
  1. Apply base sheet membranes to properly prepared substrates; prime when required by manufacturer.
  2. Unroll flashing base sheet membrane at drain level with first side lap lined up with drain centre (parallel to roof edge).
  3. Mop base sheet entirely onto prepared substrate when primer coat has flashed over; and overlap side laps and overlap end laps and stagger end joints.
  4. Composite Coverboard with Factory Laminated Base Sheet (if used): Apply in accordance with manufacturer's written instructions and in accordance with CSA A123.21 tested assembly, and as follows:
    1. Stagger coverboard joints with insulation joints.
    2. Seal all end laps using manufacturer's approved tape.
8. Flashing Base Sheet Installation: Prime substrates and apply flashing base sheet in accordance with manufacturer's written instructions; similarly, as membrane base sheet, and as follows:
  1. Install flashing base sheet onto curbs, parapets and upstands, and roofing membranes using methods that reduces excessive layering.
  2. Apply flashing base sheet directly onto substrate, layering from top to bottom.
  3. Apply manual uniform pressure to obtain homogenous adhesion over entire surface.

4. Torch-weld seams that are not self-adhering.
  5. Nail in accordance with manufacturer's written instructions.
  6. Use hand roller to remove air bubbles, wrinkles, and fish mouths.
9. Roofing Membrane Cap Sheet Installation: Apply cap sheet in accordance with manufacturer's written instructions after completion of base sheet membrane application and correction of defects, and as follows:
1. Unroll cap sheet at drain and align first side lap (parallel to roof edge).
  2. Torch Applied Cap Sheet Installation:
    1. Relax membrane rolls minimum of 20 minutes prior to application. Apply parallel to roof edge and centred over drain.
    2. Weld cap sheet onto base sheet and achieve full weld between base and cap sheet membranes with no voids or air pockets.
    3. Overlap side laps and overlap end laps, and stagger end joints, and offset and stagger cap sheet laps from base sheet laps.
    4. Trim corners at end laps covered by next roll and remove granules from overlap surfaces.
    5. Verify that overlapped joints are fully sealed after cap sheet is installed, leaving bleed out at joints ungranulated until reviewed and accepted by the Consultant; and
    6. Apply coloured granules matching cap sheet colour to bleed out lines to match appearance of adjacent membranes.
  3. Flashing Cap Sheet Installation: Install flashing cap sheet in accordance with manufacturer's written instructions; similarly, as membrane cap sheets, and as follows:
    1. Verify that overlapped joints are fully sealed after cap sheet is installed, leaving bleed out at joints ungranulated until reviewed and accepted by the Consultant.
    2. Apply coloured granules matching cap sheet colour to bleed out lines using manufacturer's recommended adhesive and shake granules onto surface and press into place while adhesive is tacky to match appearance of adjacent membranes.
10. Waterproofing at Roof Drain Penetrations: Install roof drains in accordance with the requirements of Division 22 – Plumbing, and in accordance with manufacturer's instructions to obtain a leak free connection between drain body and roof membrane.
1. Waterproofing at other Roof Penetrations: Install waterproofing membranes in accordance with manufacturer's standard details for penetration type.
11. Sheet Metal Flashing and Trims: Complete flashing work using specified materials described on plans and details, and as described in Section 07 62 00 – Sheet Metal Flashing and Trim, and as follows:
1. Use nails, staples, screws, bolts, washers, and other metal fasteners that are compatible with flashing materials and are manufactured from rustproof metals, of same colour as surfaces with which they are in contact.
  2. Sheet metal work will conform to details, with plumb profiles free from deformities or defects that may hinder appearance
  3. Space angles, fasteners, and seams to allow for normal expansion and contraction.
  4. Use concealed type fasteners unless Consultant approves exposed fasteners in designated locations prior to installation.
  5. Fasten sheet metalwork at corners and angles, with faces aligned evenly.
  6. Apply sealant to sheet metal joints and junctions with other materials.
  7. Scrape out mortar joints to 25 mm depth and insert flashing, fasten, and apply sealant at junctions between roof and masonry surfaces; and
  8. Install appropriate flashing, cap sheet, counter flashing, casings and other accessories to vents, pipes and ducts and other penetrations.

12. Walkway Installation:

1. Walkway Cap Sheet Strips (Traffic Course): Install roofing membrane walkway cap sheet strips in contrasting colour as specified above over roofing membrane by torch application. Refer to Drawings for established path of travel.

**3.4 CLOSEOUT ACTIVITIES**

1. Cleaning: Routinely clean project site of rubbish and other materials that may hinder roof installation, performance, or present a fire hazard, and as follows:
  1. At completion of work remove waste materials and items that could cause a roof puncture; and
  2. Clean adjacent surfaces of asphalt, bitumen, and other roofing materials deleterious to appearance or function.
2. Repairing and Restoring: In the event of materials damage by the elements, improper handling, or other causes, such materials will be rejected. Replace materials at no extra cost to the Owner; remove rejected materials promptly from the site.
3. Protection: Contractor is responsible for providing protection of work and materials installed by this Section from work of subsequent trades until Substantial Performance of the Work.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of sheet metal flashing and trim intended to protect membranes from accelerated deterioration arising from exposure to the elements, and to protect the building from migration of moisture into vulnerable assemblies by diverting water to the exterior or other drainage plane. Sheet metal flashing and trim for this project includes, but is not limited to, exposed trims, metal flashing, overhead piping safety pans.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. Aluminum Association (AA):
  1. Designation System for Aluminum Finishes, 2003
  2. Guidelines for Aluminum Sheet Metal Work in Building Construction, 2000
3. American National Standards Institute (ANSI):
  1. ANSI H35.1/35.1M-2017, American National Standard Alloy and Temper Designation Systems for Aluminum, 2017
4. American Society for Testing and Materials (ASTM International):
  1. ASTM B32-20, Standard Specification for Solder Metal
  2. ASTM B209/B209M-21, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  3. ASTM A792/A792M-21a, Standard Specification for Steel Sheet, 55% Aluminum Zinc Alloy Coated by the Hot-Dip Process
5. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 37.5-M89, Cutback Asphalt Plastic Cement
  2. CAN/CGSB 37.29-M89, Rubber/Asphalt Sealing Compound
  3. CAN/CGSB 51.32-M77, Sheathing, Membrane, Breather Type
6. Canadian Standards Association (CSA Group):
  1. CSA A123.3-05 (R2015), Asphalt Saturated Organic Roofing Felt
7. Roofing Association Publications:
  1. Canadian Roofing Contractors Association (CRCA): Canadian Roofing Reference Manual
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
  1. Architectural Sheet Metal Manual, 5th Edition, 2012

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination:
  1. Coordinate work of this Section with interfacing and adjoining Work for proper sequencing of each installation and to provide positive weather resistance, durability of the work, and protection of materials and finishes.
  2. Coordinate work of this section with the requirements of other technical sections forming part of Division 07 – Thermal and Moisture Protection, for specific requirements for supply of prefinished sheet metal flashing materials to other sections of the work as follows:



1. Supply prefinished sheet metal flashings required for the project, regardless of sheet metal thickness and colour.
2. Provide prefinished sheet metal flashings to installing trades, tension levelled, and guillotine sheared to length ready for brake forming, fabrication and installation by installing trades.
3. Coordinate with installing trades during bid period and obtain the quantity, thickness and colour of flashing materials required under their respective scopes of work and include in the preformed metal wall and cladding Bid Price.
4. Subcontractor will be entitled to additional payment from installing trades where quantity, thickness or colour of prefinished metal flashings is different than indicated during the bid period, as follows:
  1. Additional payment will not be considered as a change to the Contract where difference is the result of an estimating error on the part of the installing trade, and payment shall be coordinated with the Contractor.
  2. Additional payment will be considered as a change to the Contract where difference is a result of a change in design or material directed by the Consultant and will be administered in accordance with the requirements of the General Conditions of Contract.
5. Requirements of this portion of the scope of work do not apply to extruded aluminum or other pre-manufactured flashing materials normally supplied by installing trades (i.e.: extruded aluminum curtain wall flashing and sills, preformed roof penetrations, non-prefinished sheet metal products).
6. Subcontractor responsible for supply of metal wall and soffit cladding will only be responsible for fabrication and installation of flashings relating to their scope of work.

#### 1.5 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.

#### 1.6 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Installer: Engage an experienced installer having a minimum of three (3) years experience who has completed projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

### 2 Products

#### 2.1 MATERIALS

1. Aluminum/Zinc Galvanized Sheet Steel Cladding: Tension levelled, Commercial Steel (CS) designation, Type A, Grade 275 in accordance with ASTM A792/A792M, and as follows:
  1. Thickness: Minimum 0.45 mm base metal thickness, and as modified by Item 2.5 below.
  2. Galvanizing Designation: AZM180, applied evenly to both sides.
  3. Acceptable Products:
    1. Dofasco Inc., Galvalume.
2. Formed Aluminum Flashings: Tension levelled, aluminum sheet in accordance with ASTM B209/B209M and ANSI H35.1/H35.1M alloy designation 3003H14, and as follows:
  1. Thickness: Minimum 1.0 mm, and as modified below in this Section.
  2. Aluminum Flashing: Prefinished colour as indicated on Drawings using Duranar coatings.

## 2.2 ACCESSORIES

1. Solder: ASTM B32, Grade Sn50, used with rosin flux for galvanized steel flashings.
2. Fasteners: Same metal as sheet metal flashing or other non-corrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.
3. Dielectric separator: Bituminous paint: Isolation coating between aluminum and other metallic materials, concrete and preservative treated wood, acid, and alkali resistant asphaltic paint in accordance with MPI Architectural Painting Specification Manual Approved Product listing MPI #35.
4. Asphalt Mastic: Solvent type asphalt mastic, nominally free of sulphur and containing no asbestos fibres, compounded for 0.40 mm dry film thickness per coat.
5. Mastic Sealant: CAN/CGSB 37.29 polyisobutylene; non-hardening, non-skinning, non-drying, non-migrating sealant.
6. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Section 07 92 00 – Joint Sealants.
7. Epoxy Seam Sealer: Two component, non-corrosive, aluminum seam cementing compound, recommended by aluminum manufacturer for exterior and interior non-moving joints, including riveted joints.
8. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather resistant seaming and adhesive application of flashing sheet metal.
9. Slip Sheet: CSA A123.3, No. 15 perforated asphalt saturated felts.
10. Flexible Flashing: Polyethylene faced bituminous membrane materials compatible with membrane air and vapour membrane specified in Section 07 27 16 – Air Barrier Membrane, not less than 0.5 mm thick and be compatible with all other materials being used and mastic compatible and approved for use with the flashing material.
11. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; non-corrosive; size and thickness required for performance.
12. Roofing Cement: CAN/CGSB 37.5, asbestos free, asphalt based.

## 2.3 FABRICATION

1. Fabricate sheet metal building flashings and trim in accordance with the recommendations of SMACNA's Architectural Sheet Metal Manual that apply to the design, dimensions, metal, and other characteristics as required.
2. Fabricate sheet metal roofing flashings in accordance with the recommendations of the CRCA, and as follows:
  1. Make flashing of prefinished metal for all flashings adjacent to roofing at roof edges and area dividers and where exposed to view from ground.
  2. Make flashing for other roof locations, of plain galvanized metal.
3. Fabricate flashings using the following metal core thicknesses:
  1. Flat Surfaces Less Than 300 mm in Width or Height: Use 0.45 mm material except where specifically noted otherwise.
  2. Flat Surfaces 300 mm and Greater in Width or Height: Use 0.62 mm material except where specifically noted otherwise.
  3. Concealed Fastening Strips: Use 0.80 mm material.
4. Fabricate sheet metal flashing and trim to fit substrates and result in waterproof and weather resistant performance once installed.

5. Fabricate scuppers to dimensions indicated on Drawings, with closure flange trim to exterior, 100 mm wide wall flanges to interior, and base extending 100 mm beyond cant or tapered into field of roof. Fabricate scuppers from aluminum/zinc galvanized sheet steel as specified above in this Section.
6. Verify shapes and dimensions of surfaces being covered before fabricating sheet metal.
7. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
8. Seams:
  1. Fabricate non-moving seams in sheet metal with flat lock seams.
  2. Tin edges being seamed, form seams, and solder.
9. Seams: Fabricate non-moving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
10. Expansion Provisions:
  1. Space movement joints at 3050 mm o/c with no joints allowed within 610 mm of corners or intersections.
  2. Form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with mastic sealant concealed within joints where lapped or bayonet type expansion provisions cannot be used or are not sufficiently weatherproof and waterproof.
11. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant in accordance with SMACNA standards.
12. Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
13. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
14. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, non-corrosive metal recommended by sheet metal manufacturer, and as follows:
  1. Size as recommended by SMACNA manual or sheet metal manufacturer for application but not less than thickness of metal being secured.
15. Aluminum Extrusion Units: Fabricate extruded aluminum running units with formed or extruded aluminum joint covers for installation behind main members where possible. Fabricate mitred and welded corner units.

### **3 Execution**

#### **3.1 EXAMINATION**

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

1. Install sheet metal flashing and trim in accordance with performance requirements, manufacturer's installation instructions, and SMACNA's Architectural Sheet Metal Manual.
2. Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated.
3. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.

4. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather resistant performance.
5. Verify shapes and dimensions of surfaces being covered before fabricating sheet metal.
6. Flashings Securement: Secure metal flashings using clips at a maximum of 610 mm o/c.
7. Expansion Provisions:
  1. Provide for thermal expansion of exposed sheet metal Work.
  2. Space movement joints at maximum of 3050 mm with no joints allowed within 610 mm of corner or intersection.
  3. Form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with mastic sealant (concealed within joints) where lapped or bayonet type expansion provisions in work cannot be used or are not sufficiently weatherproof and waterproof.
8. Soldered Joints:
  1. Clean surfaces being soldered, removing oils and foreign matter.
  2. Pre-tin edges of sheets being soldered to a width of 38 mm, except where pre-tinned surface would show in finished Work.
  3. Do not solder the following metals:
    1. Aluminum.
    2. Coil coated galvanized steel sheet.
  4. Pre-tinning is not required for the following metals:
    1. Lead.
    2. Lead coated copper.
    3. Terne coated stainless steel.
  5. Do not use torches for soldering.
  6. Heat surfaces to receive solder and flow solder into joint.
  7. Fill joint completely.
  8. Completely remove flux and spatter from exposed surfaces.
9. Sealed Joints:
  1. Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant in accordance with SMACNA standards.
  2. Fill joint with sealant and form metal to completely conceal sealant.
  3. Use joint adhesive for non-moving joints specified not being soldered.
10. Seams:
  1. Fabricate non-moving seams in sheet metal with flat lock seams.
  2. Tin edges being seamed, form seams, and solder.
11. Seams: Fabricate non-moving seams in aluminum with flat lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
12. Separations:
  1. Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
  2. Underlayment: Install a slip sheet of red rosin paper and a course of polyethylene underlayment where installing stainless steel or aluminum directly on cementitious or wood substrates.
  3. Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.

13. Overhead Piping Safety Pans: Suspend pans from pipe and install drain line to plumbing waste or drain line.
14. Equipment Support Flashing:
  1. Coordinate equipment support flashing installation with roofing and equipment installation.
  2. Weld or seal flashing to equipment support member.
15. Roof Penetration Flashing:
  1. Coordinate roof penetration flashing installation with roofing and installation of items penetrating roof.
  2. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
  3. Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.
16. Parapet Scuppers: Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane, and as follows:
  1. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.

### 3.3 CLOSEOUT ACTIVITIES

1. Cleaning: Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
2. Protecting: Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Performance of the Work.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of roof hatches and system accessories.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate installation of roof hatches with roofing installation for membrane laps and flashings; coordinate with structural framing for roof structure and requirements for size of roof opening and support of premanufactured curbs.

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide following submittals before starting any work of this Section:
  1. Product Data: Submit product data for roof hatches including construction, hardware and finishes.
  2. Shop Drawings: Submit shop drawings indicating size and description of components, materials, attachments, description of frame and finish, and construction details.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.5 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.

## **2 Products**

### **2.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Babcock-Davis.
  2. Bilco Company.
  3. Lexsuco.
  4. Maxam Metal Products Ltd.
  5. Nystrom Inc.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### **2.2 PERFORMANCE REQUIREMENTS**

1. Design Criteria: Design roof hatches to withstand 2.0 kPa external and 0.4 kPa internal loads accounting for regional snow load requirements and a temperature range of 80°C without damage to unit or permanent deformation to seals.

## 2.3 MANUFACTURED UNITS

1. Roof Hatches: Provide roof hatches with insulated double wall lids and insulated double wall curb frame with integral deck mounting flange and lid frame counter flashing with welded sealed corner joints, continuous weather tight perimeter gasketing and hot dip galvanized hardware, and as follows:
  1. Type: Single Leaf Lid – Thermally Broken.
  2. Size: As indicated on Drawings.
  3. Curb and Lid Material: Galvanized steel sheet, nominal 2.0 mm minimum thickness.
  4. Insulation: Polyisocyanurate insulation board, minimum 25 mm thickness.
  5. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
  6. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
  7. Hardware: Stainless steel, counterbalanced spring latch with turn handles, butt or pintle type hinge system as standard for manufacturer, and padlock hasps inside and outside.
  8. Latching: Single point, using manufacturer's standard latching mechanism having hold open operating arm with vinyl grip handle to permit one handed release.
2. Fabricate curbs to maintain a minimum height of 300 mm above top of roofing membrane as indicated on Drawings; provide tapered curb to maintain level lid where slope is greater than 2% - 20 mm in 1000 mm.

## 2.4 ACCESSORIES

1. Screws: Manufacturer's standard galvanized steel for mounting curb to structure.
2. Gaskets: Resilient gasket to inner face of lid in contact with hatch lid support frame.
3. Ladder Safety Post: Manufacturer's standard nominal 40 mm Ø galvanized steel tube ladder safety post; with post locking in place on full extension to 1070 mm above roof surface and release mechanism to return post to closed position, finished with manufacturer's standard baked enamel finish.
4. Safety Railing System: Manufactured safety rail system meeting requirements of Ontario OH&S safety codes; designed to be fastened to roof hatch curb so that top of railing is minimum 1070 mm above roof surface, and as follows:
  1. System includes rails, clamps, fasteners and accessories required for a complete installation, and as follows:
    1. Joints exposed to weather to be watertight, and rail ends to be fitted with end fittings.
    2. Railing tubular sections to have weep holes or another means to drain entrapped water or condensation.
    3. Self-returning gate hardware.
  2. Finish: Powder coat finish, colour selected by Consultant from manufacturer's standard colours.

## 2.5 FINISHES

1. Galvanized Steel Finishes: Factory finished; colour selected by Consultant from manufacturer's standard colours.
2. Aluminum Finishes: Mill finish.
3. Stainless Steel Finishes: 2D dull mill finish.

## 2.6 FABRICATION

1. Fabricate components free of twists, bends, or visual distortion and insulated; with flashings designed to collect and lead off accumulated condensation.

### 3 Execution

#### 3.1 EXAMINATION

1. Verification of Conditions: Examine areas and conditions under which work of this Section is being performed and identify conditions detrimental to proper or timely completion:
  1. Verify that deck, curbs, roof membrane, base flashing, and other items affecting Work of this Section are in place and positioned correctly.
  2. Verify tolerances and correct improper conditions.
  3. Starting work of this Section indicates acceptance of conditions

#### 3.2 INSTALLATION

1. Install roof hatches watertight and fully operational in accordance with manufacturer's instructions in accordance with manufacturer's instructions and as follows:
  1. Erect components plumb, level and in proper alignment.
  2. Verify continuity of building envelope air barrier and vapour retarder systems.
  3. Adjust and seal assembly with provision for expansion and contraction of components.
  4. Secure prefabricated curb assembly to structure.
  5. Coat aluminum in contact with dissimilar materials with isolation coating.

#### 3.3 CLOSEOUT ACTIVITIES

1. Adjusting: Adjust hardware for smooth operation; clean and lubricate operating joints and hardware.
2. Cleaning: Clean exposed surfaces in accordance with manufacturer's written instructions; touch up damaged metal coatings

**END OF SECTION**



## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements for design, supply and installation of static penetrations, membranes and joint firestop systems using materials or a combination of materials required to preserve the integrity and to prevent the passage of fire and smoke in assemblies having a Fire Resistance Ratings in accordance with the applicable Building Code.
2. Firestop systems are required at the following locations having a Fire-Resistance Rating:
  1. Penetrations through horizontal assemblies requiring protected openings including empty openings and openings that contain penetrating components.
  2. Penetrations through vertical assemblies including empty openings and openings that contain penetrating components.
  3. Membrane penetrations in wall assemblies where items penetrate only one side of the barrier.
  4. Joints in assemblies that allow for independent movement between assembly components.
  5. Perimeter of horizontal assemblies having a Fire-Resistance Rating and exterior wall assemblies.
  6. Joints, through penetrations and membrane penetrations in assemblies intended to limit, restrict, or retard the circulation of smoke.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM E90-09(2016), Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Element
  2. ASTM E2174-20a, Standard Practice for On-Site Inspection of Installed Firestop Systems
  3. ASTM E2307-20, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus
  4. ASTM E2393-20a, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
3. International Firestop Council (IFC):
  1. Recommended IFC Guidelines for Evaluating Firestop Systems in Engineering Judgments
  2. Recommended IFC Guidelines for Evaluating Firestop Systems in Engineering Judgements: Perimeter Fire Barrier Systems
  3. Recommended IFC Guidelines for Evaluating Firestop Systems in Engineering Judgments on Fire Resistant Duct Enclosure Systems for Ventilation Ducts
  4. Recommended IFC Guidelines for Evaluating Firestop Systems in Engineering Judgments on Fire Resistant Duct Enclosure Systems for Commercial Kitchen Exhaust Ducts
4. Firestop Contractors International Association (FCIA):
  1. FCIA Manual of Practice
5. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S101-14, Standard Methods of Fire Endurance Tests of Building Construction and Materials
  2. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

3. CAN/ULC S114:2018, Standard Method of Test for Determination of Non-Combustibility in Building Materials
4. CAN/ULC S115-2018, Standard Method of Fire Tests of Firestop Systems
5. ULC Firestop Systems and Components

#### 1.4 DEFINITIONS

1. Refer to Section 07 05 53 – Fire and Smoke Assembly Identification for additional definitions; coordinate and incorporate common work requirements specified in Section 07 05 53 – Fire and Smoke Assembly Identification with work of this Section.
2. Fire-Resistance Rating: The time in minutes or hours that a material or assembly of materials will withstand the passage of flame and transmission of heat when exposed to fire meeting the requirements of CAN/ULC S101 or as determined by formal testing of material or assembly of materials meeting requirements of CAN/ULC S115, or an interpretation of information derived from formal testing in accordance with requirements of the Building Code and acceptable to the Authority Having Jurisdiction.
3. Fire Separation: Assembly that acts as a barrier against the spread of fire, smoke and noxious gases resulting from combustion as defined by the Building Code and includes the following assemblies having a Fire-Resistance Rating requiring Fire Stopping as follows:
  1. Penetration-Type firestop systems located within load bearing walls and partitions.
  2. Penetration-Type Fire Stop systems located within non-load bearing walls and partitions.
  3. Penetration-Type located within floor assemblies.
  4. Building Perimeter-Type located between floor assemblies and exterior wall and roof construction.
  5. Construction Joint-Type and other assemblies having a Fire-Resistance Rating indicated on Drawings or Schedules.
4. Fire Compartment: Spaces within a building that are enclosed by exterior walls or separated from other parts of the building by enclosing Fire Separations having a Fire-Resistance Rating.
5. Firewall: Assembly that is a Fire Separation constructed from non-combustible construction subdividing a building or separating adjoining buildings to resist the spread of fire and that has a Fire-Resistance Rating, and structural stability to remain intact under fire conditions for the required fire-rated time.
6. Fire Stop: System consisting of a material, component or combination of materials and components used to fill gaps between Fire Separations or between Fire Separations and other assemblies or used around items that wholly or partially penetrate a Fire Separation.
7. Membrane Penetration: An opening made through one side of an assembly having a Fire-Resistance Rating; and that is not an opening that penetrates completely through that assembly, and that a Fire Stop system is installed to maintain the integrity of the Fire-Resistance Rating of that assembly.
8. Qualified Supervisor or Installer: The Contractor's supervisor or a specialty Subcontractor that can demonstrate their skill and knowledge for the design and installation of Fire Stop systems of similar complexity and extent required for the Project, and that can certify installation was completed in accordance with ULC Listed Assemblies submitted as a component of shop drawing Submittals.
9. Qualified Firestop Contractor: A Subcontractor that has completed the ULC Qualified Firestop Contractor Program or other acceptable accreditation program described in this Section, and that can provide proof of continued compliance with the training and accreditation program.

## 1.5 ADMINISTRATIVE REQUIREMENTS

1. Pre-Construction Meeting: Arrange a pre-construction meeting in accordance with Section 01 31 19 – Project Meetings, attended by Contractor, Subcontractor responsible for Firestopping, Firestopping manufacturers' representatives, Subcontractors affected by work of this Section, and the Consultant to discuss the following requirements:
  1. Confirm extent of standard materials and systems, and identify materials and systems that will require Engineered Judgements or Equivalent Fire Resistance Rated Assemblies
  2. Confirm site conditions, coordination issues and single source installation responsibility for application of Firestopping systems; either by a specialty Firestopping Subcontractor or the by the Contractor where Contractor can show proof of qualifications required by this Section.
2. Coordination: Project coordination is essential to inform and educate all contributors involved with or affected by installation of Firestopping systems, so that their role in protecting and maintaining the integrity of Firestopping systems is understood, and as follows:
  1. Coordinate with other trades and verify that pipes, conduit, cable, and other items penetrating Fire-Resistance Rated assemblies are permanently installed prior to installation of firestop assemblies.
  2. Coordinate construction of openings and penetrating items and verify that Firestopping systems are installed according to specified requirements and as follows:
  3. Coordinate sizing of sleeves, openings, core drilled holes, or cut openings to accommodate Firestopping systems; diameter of sleeves or cored holes must match listed system for the device.
  4. Leave Firestopping installations that will become concealed behind other construction open until Consultant and building inspector; if required by Authority Having Jurisdiction, have examined each installation.

## 1.6 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's product data for materials and prefabricated devices as follows:
    1. Include manufacturer's installation instructions, descriptions of system composition and limitations of installation.
    2. Include confirmation that installed systems meet requirements of ULC or CUL Firestopping Systems and Components where installation fully matches listed assembly.
    3. Include copies of Equivalent Fire Resistance Rated Assembly where similar conditions as tested assemblies do not meet project installation conditions, and where installation does not require a full Engineered Judgement.
    4. Include copies of Equivalent Fire Resistance Rated Assembly (EFRA) or Engineered Judgements (EJ) clearly indicating EFRA and EJ identification numbers, project name, installing Subcontractor's name when no ULC or CUL system is available to meet project installation conditions.
  2. Firestop System Schedule: Submit schedule prepared by installing Subcontractor indicating locations of firestop systems as follows:
    1. Consultant's Project Number and Project Name.
    2. Installing Subcontractor's Name and Address.
    3. Listing of Manufacturers Names and Addresses for products used on the Project.
    4. Name of Contractor or Subcontractor's Qualified Supervisor.

5. Manufacturers' Product Reference for each type of penetrating item and joint sealant, including:
  6. Listing Agency (ULC, cUL or FM) Number for each different location and assembly type.
  7. Designated Rating (F, T, FT, H, W or L) appropriate to the penetrations or joint condition.
  8. Types of assemblies being penetrated, listing Fire-Resistance Ratings and thickness of construction.
  9. EFRRA and EJ numbers for non-classified firestop systems.
3. Informational Submittals: The following are required before starting any work of this Section:
1. Material Certificates: Submit written certification prepared by firestopping manufacturer stating that products supplied to the Project comply with local regulations controlling use of volatile organic compounds (VOCs) and are non-noxious to building occupants.
  2. Installer Qualifications: Submit certificate indicating that personnel are trained and qualified to install firestopping products described in this section, issued by firestopping manufacturer.
  3. Site Quality Control Submittals: Submit manufacturers record of site observations and any recommendations or modification for site installed components to Consultant immediately following completion of manufacturer's Site Quality Control Activities.

#### 1.7 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 00 10 – General Requirements: Closeout Submittals; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

#### 1.8 QUALITY ASSURANCE

1. Regulatory Requirements: Use materials and methods of determining required thickness of application that have the full acceptance of Authority Having Jurisdiction and that are tested in accordance with ULC S115, and that form apart of a ULC or CUL listed system, Engineered Judgement or Equivalent Fire Resistance Rated Assembly.
2. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Installer: Use a firestopping Subcontractor that has completed the ULC Qualified Firestop Contractor Program and that employs experienced applicators having experience with similar systems and complexity as required for the Project, using proper equipment in strict accordance with manufacturer's written installation instructions for tested and listed systems designs, Engineering Judgements or Equivalent Fire Resistance Rated Assemblies.
  2. Single Source Installation Responsibility: Obtain firestop systems, for each kind of penetration and construction condition required for the project from a single source of installation responsibility to the greatest extent possible.

#### 1.9 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver and store materials in a dry protected area, in original undamaged sealed containers with the manufacturer's labels, application instructions, and labelling agency's labels intact.
2. Storage and Handling Requirements: Keep materials dry until ready for use and as follows:
  1. Keep the packages of material off the ground, under cover, and away from sweating walls and other damp surfaces. Discard material that has been exposed to water before actual use.
  2. Use stock before its expiration date.

## 1.10 SITE CONDITIONS

1. Ambient Conditions: Install firestop systems when ambient or substrate temperatures are within temperature and moisture limits permitted by firestopping system manufacturers or when substrates are not wet due to rain, frost, condensation, or other causes.
2. Ventilation: Ventilate areas where firestop systems are being installed in accordance with manufacturer's written instructions by natural means or forced air circulation where natural means are not adequate.
3. Installation Conditions: Install firestopping materials only when the areas in which they are scheduled are closed-in and protected from dampness.

## 2 PRODUCTS

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Passive Fire Protection Partners.
  2. Hilti Inc.
  3. Specified Technologies Inc. (STI)
  4. 3M.
  5. Tremco Ltd.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Fire Resistance Rated Assemblies: Materials described on the Drawings and within this Section are based on generic contributions listed in the Building Code and as follows:
  1. Fire-Resistance Ratings: Products used in assemblies having a Fire-Resistance Rating must be constructed, applied, or installed in accordance with assemblies tested and approved by agencies acceptable to the Authority Having Jurisdiction.
  2. Products: Provide systems having fire test response characteristics in accordance with requirements specified in Section 07 05 53 – Fire and Smoke Assembly Identification, and as follows:
    1. Individual products and materials containing only a testing agency mark without reference to a specific ULC or cUL listed assembly are not acceptable.
    2. Use only materials matching the tested and listed system; do not mix materials from of different manufacturers in the same firestop system or opening that do not form a component of the tested and listed system.
    3. Single source of product and materials responsibility is not required, multiple product and material sourcing is encouraged to obtain the widest selection of tested and listed systems for the project.
    4. Products from different manufacturers are permitted; provided they are not intermixed with other manufacturers' products, to maintain maximum opportunity for installation of tested and listed systems.
    5. Use a different manufacturer that has a tested and listed system before submitting an Engineering Judgment or Equivalent Fire Resistance Rated Assembly.

3. Limitations of Qualifications: Installation of products and materials specified in this Section require experienced installers that are certified or otherwise licensed, and who have received installation training provided by firestopping manufacturers:
  1. Willingness from a supplier or manufacturer to sell firestopping products to entities other than those qualified to perform work of this Section as specified, does not confer qualifications to the buyer of those products.
  2. Failure to provide proof of qualifications when requested by the Consultant will denote automatic rejection of any firestop system proposed for use.
2. Delegated Design Requirements: Design Fire Stopping required by the Contract Documents to withstand Fire-Resistance Ratings indicated and in accordance with the Building Code, and as described in Section 07 05 53 – Fire and Smoke Assembly Identification, and as follows:
  1. Design Fire Stop systems for empty openings and openings containing penetrating items.
  2. Design Fire Stop systems that are manufactured resist spread of fire in accordance with specified requirements, that resist passage of smoke and noxious gases, and that maintain original Fire-Resistance Rating of construction penetrated.
  3. Design Fire Stopping at openings intended for ease of re-entry such as cables using elastomeric or flexible seals; do not use cementitious or rigid seals at these locations.
  4. Design Fire Stopping at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control using elastomeric or flexible seals; do not use cementitious or rigid seal at these locations.
  5. Design Fire Stopping at fire damper locations so as not to restrict the expansion or contraction of the penetrating ductwork or interfere with the ability of the damper to drop into place and operate correctly.
  6. Design Fire Stopping using tested assemblies to the greatest extent possible; use of Engineered Judgements and Equivalent Fire Resistance Rated Assemblies should only be submitted for review when a tested assembly is not available from any of the listed acceptable manufacturers.
3. Firestopping Design Conditions: Following conditions apply to firestopping systems proposed for use in the Project:
  1. Penetrations: Provide materials meeting the following criteria:
    1. Performance Rating: F, FT or FTW-Rated applicable to assembly being penetrated.
    2. Assembly Rating: Time rating for Fire-Resistance Rating and Temperature Rise Resistance Rating applicable to assembly being penetrated.
    3. Nominal Annular Width: As indicated.
    4. Movement Capabilities: Not Required.
  2. Floor-to-Wall, Fire Resistive Joint System: Provide materials meeting the following criteria:
    1. Performance Rating: F, FT or FTW-Rated applicable to assembly being penetrated.
    2. Assembly Rating: Time rating for Fire-Resistance Rating and Temperature Rise Resistance Rating applicable to assembly being sealed.
    3. Nominal Joint Width: As indicated.
    4. Movement Capabilities: Compression, extension, and horizontal shear.
  3. Head-of-Wall, Fire Resistive Joint System: Provide materials meeting the following criteria:
    1. Performance Rating: F or FT-Rated applicable to assembly being penetrated.
    2. Assembly Rating: Time rating for Fire-Resistance Rating and Temperature Rise Resistance Rating applicable to assembly being sealed.
    3. Nominal Joint Width: As indicated.
    4. Movement Capabilities: Compression and extension.
    5. Refer to Section 09 22 16 – Non-Structural Metal Framing and Section 09 29 00 – Gypsum Board for head of wall systems installed as a component of steel stud framed partitions.

4. Wall-to-Wall, Fire Resistive Joint System: Provide materials meeting the following criteria:
  1. Performance Rating: F or FT-Rated applicable to assembly being penetrated.
  2. Assembly Rating: Time rating for Fire-Resistance Rating and Temperature Rise Resistance Rating applicable to assembly being sealed.
  3. Nominal Joint Width: As indicated.
  4. Movement Capabilities: Compression and extension.
4. Provide manufacturer's proprietary assemblies designed to seal penetrations through and perimeters around Fire Separation or Firewall assemblies having a Fire-Resistance Rating equal to or greater than the Fire-Resistance Rating of the Fire Separation or Firewall assemblies in accordance with REFERENCE STANDARDS and the Building Code, and as follows:
  1. Thickness and Composition of Materials: Determine thickness and composition of applied materials based on tests of assemblies identical to the assembly being protected where possible.
  2. Engineering Judgements: Determine system composition based on available engineering studies, or correspondence with the labelling agency indicating the effect that differences within Fire Separation where the assembly is protected but does not correspond exactly to a tested assembly; confirm acceptance of system by local Authority Having Jurisdiction in writing.
  3. Equivalent Fire Resistance Rated Assembly: Use the same system and material as would be required for a tested assembly with similar conditions where the assembly includes conditions that do not correspond to those included in any previously tested assembly and that do not have relevant engineering information available at the time of installation.
  4. Acoustic Ratings: Use firestop products that provide a minimum of STC 55 within sound rated assemblies.

## 2.3 MATERIALS

1. Systems: Provide Fire Stop systems that are tested in accordance with ULC S115 and comprised of asbestos free materials capable of maintaining an effective barrier against flame, smoke, and noxious gases, and sized for opening sizes for which they are intended based on Fire-Resistance Ratings indicated on Drawings, and as follows:
  1. F-Rated Through-Penetration Firestop Systems: Provide through-penetration firestop systems that resist passage of smoke and noxious gases at ambient and elevated temperatures, with F and L ratings meeting or exceeding the fire-resistance ratings of construction being penetrated.
  2. T-Rated Through-Penetration Firestop Systems: Provide firestop systems with T ratings in addition to F ratings described above when temperature rise resistance is a performance requirement of construction being penetrated.
  3. L-Rated Through-Penetration Firestop Systems: Provide firestop systems with L ratings for assemblies requiring only ambient temperature smoke and noxious gas resistance, without additional F or T requirements.
  4. W-Rated Through-Penetration Firestop Systems: Provide firestop systems with W ratings, in addition to F, T and L ratings when site conditions require water resistance as an assembly performance requirement.
2. Systems Exposed to View: Provide products that after curing do not deteriorate when exposed to traffic, moisture, and physical damage and as follows:
  1. Provide moisture resistant through penetration firestop systems for piping penetrations for plumbing and wet pipe sprinkler systems, and at the floor joint of fire rated gypsum board assemblies.
  2. Provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means for floor penetrations with annular spaces exceeding 100 mm in width and exposed to possible loading and traffic.

3. Provide firestop systems not requiring removal of insulation for penetrations involving insulated piping.
4. Provide products with flame spread ratings of less than 25 and smoke developed ratings of less than 50 for firestopping and joint systems exposed to view in accordance with CAN/ULC S102.
3. Compatibility: Provide Fire Stop systems that are compatible with one another, with the substrates forming openings, and with the items penetrating Fire Stop systems, under conditions of service and application, as demonstrated by Fire Stopping system manufacturer based on testing and site experience, and as follows:
  1. Service Penetration Assemblies: Certified by ULC in accordance with ULC S115 and listed in ULC List of Equipment and Materials, Firestop Systems and Components.
  2. Service Penetration Fire Stopping Components: Certified by ULC in accordance with ULC S115 and listed in ULC List of Equipment and Materials, Firestop Systems and Components.
4. Accessories: Provide components for each Fire Stopping system that are needed to install fill materials and to comply with Reference Standards above, using only components specified by Fire Stopping system manufacturer and approved by the qualified testing and inspecting agency for Fire Stop systems indicated. Accessories include, but are not limited to, the following items:
  1. Permanent forming, damming, and backing materials, including the following:
    1. Slag or rock wool fibre insulation.
    2. Sealants used in combination with other forming, damming, or backing materials to prevent leakage of fill materials in liquid state.
    3. Fire rated form board.
    4. Fillers for sealants.
  2. Temporary forming materials.
  3. Substrate primers.
  4. Collars.
  5. Steel sleeves.
  6. Primers: to manufacturer's recommendation for specific material, substrate, and end use.
  7. Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
  8. Metal Fire Stop: Commercial galvanized steel, having minimum 260 g/m<sup>2</sup> zinc coating and minimum nominal metal core thickness 0.9 mm.
  9. Labels: Provide peel-and-stick labels as specified in Section 07 05 53 – Fire and Smoke Assembly Identification, printed with the following information:
    1. ATTENTION: FIRE RATED ASSEMBLY. DO NOT MODIFY.
    2. Name of Fire Stopping manufacturer.
    3. Names of products used.
    4. Fire-Resistance Rating of Assembly.
    5. Manufacturers standard detail number, Engineered Judgement or Equivalent Fire Resistance Rated Assembly identifier; ULC or CUL Number.
    6. Date of installation.
    7. Name of installing Subcontractor.
    8. Contact telephone number for repair or replacement of Fire Stopping materials.

## 2.4 FILL MATERIALS

1. Provide only fill materials that are referred to in listed assemblies of the referenced testing and inspecting agencies as fill, void, or cavity materials.
2. Latex or Acrylic Sealants: Single-component latex or acrylic formulations that do not re-emulsify after cure during exposure to moisture.



3. Fire Stopping Devices: Factory assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrating item.
4. Cable Penetration Devices:
  1. Pre-manufactured intumescent blocks, as follows:
    1. Hilti CFS-BL Intumescent Blocks
    2. Roxtec Intumescent Blocks
  2. Pre-manufactured sleeves, consisting of an adjustable core, and as follows:
    1. Hilti CP 653 Speed Sleeves
    2. Specified Technologies EZ-Path Fire Rated Pathway
  3. Pre-manufactured cable management system, consisting of a system of intumescent inserts and adjustable cores, and as follows:
    1. Hilti Transit.
    2. Roxtec Preformed Fire Stopping Systems.
5. Intumescent Composite Sheets: Rigid panels consisting of aluminum foil faced elastomeric sheet bonded to galvanized steel sheet.
6. Intumescent Putties: Non-hardening dielectric, water resistant putties containing no solvents, inorganic fibres, or silicone compounds.
7. Intumescent Spray Foam: Expanding spray-in-place intumescent foam sealant.
8. Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.
9. Mortars: Pre-packaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
10. Pillows/Bags: Reusable, heat expanding pillows/bags consisting of glass fibre cloth cases filled with a combination of mineral fibre, water insoluble expansion agents and fire-retardant additives.
11. Silicone Foams: Multi-component, silicone based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
12. Silicone Sealants: Moisture curing, single component, silicone based, neutral curing elastomeric sealants of grade indicated below:
  1. Grade for Horizontal Surfaces: Pourable (self-levelling) formulation for openings in floors and other horizontal surfaces.
  2. Grade for Vertical Surfaces: non-sag formulation for openings in vertical and other surfaces.

## 2.5 MIXING

1. Mixing: Mix components and materials in accordance with Fire Stopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Prepare surfaces in contact with Fire Stopping materials in accordance with manufacturer's instructions.
  1. Maintain insulation around pipes and ducts penetrating Fire Separation without interruption to vapour barrier where applicable.
  2. Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.
2. Provide and maintain masking, drop cloths and polyethylene coverings for such surfaces to protect them during installation operations where adjacent finished floors, walls and similar surfaces are exposed.
3. Provide complete enclosures and human protective devices when installing or mixing hazardous materials.
4. Surfaces shall be free of oil, grease, dirt, loose paint, mill scale or any other matter that could impair bond, including paint.
5. Prime surfaces as required.
6. Make provisions for natural ventilation during and subsequent to application of Fire Stopping, sealant or caulking; circulate interior air by use of temporary circulators or exhaust fans in enclosed areas or areas lacking openings for natural ventilation.

#### 3.3 INSTALLATION

1. Apply Fire Stopping materials in strict accordance with manufacturer's written instructions, accepted and approved tested assemblies, and details submitted for Consultant's acceptance.
2. Apply Fire Stopping materials/systems to maintain the Fire Separations in the project as indicated on Drawings; apply Fire Stop materials to partitions enclosing Fire Compartments to top, bottom, and sides.
3. Seal holes or voids made by through penetrations, poke through termination devices, and unpenetrated openings or joints and verify continuity and integrity of Fire Separation are maintained.
4. Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
5. Tool or trowel exposed surfaces to a neat finish.
6. Remove excess compound promptly as work progresses and upon completion.
7. Place self-sticking labels on a permanent surface adjacent to Fire Stopping installation.

#### 3.4 CLOSEOUT REQUIREMENTS

1. Cleaning: Clean off excess fill materials and sealants adjacent to openings and joints as work progresses; use methods and cleaning materials approved by manufacturers of firestopping products and or assemblies in which penetrations, openings, gaps, and joints occur.

2. Protection: Protect firestopping during and after curing period from contact with contaminating substances; Subcontractor is responsible for making appropriate repairs, Contractor will charge appropriate trades responsible for contributing to damages.

### 3.5 SYSTEM SCHEDULE

1. Drawings indicate basic firestop details only and indicate performance expectations only, Subcontractor is responsible for submitting manufacturer's standard design for products supplied to the Project and include modifications to firestop systems required to meet site installation conditions, obtaining EFRRA and EJ numbers when site conditions differ from manufacturer's standard details.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements for joint sealant products, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer's testing and site experience and includes for the application types and other applications specified by reference to this Section.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM C834-17, Standard Specification for Latex Sealants
  2. ASTM C919-22, Standard Practice for Use of Sealants in Acoustical Applications
  3. ASTM C920-18, Standard Specification for Elastomeric Joint Sealants
  4. ASTM C1184-18e1, Standard Specification for Structural Silicone Sealants
  5. ASTM C1193-16, Standard Guide for Use of Joint Sealants
  6. ASTM C1247-20, Standard Test Method for Durability of Sealants Exposed to Continuous Immersion in Liquids
  7. ASTM C1248-18, Standard Test Method for Staining of Porous Substrate by Joint Sealants
  8. ASTM C1311-14, Standard Specification for Solvent Release Sealants
  9. ASTM C1330-18, Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
  10. ASTM C1481-12(2017), Standard Guide for Use of Joint Sealants with Exterior Insulation and Finish Systems (EIFS)
  11. ASTM D2240-15e1(2021), Standard Test Method for Rubber Property - Durometer Hardness
  12. ASTM E90-09(2016), Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
3. Canadian General Standards Board (CGSB):
  1. CGSB 19-GP-5M, Sealing Compound, Single component, Acrylic Base, Solvent Curing
  2. CGSB 19-GP-14M, Sealing Compound, Single component, Butyl-Polyisobutylene Polymer Base, Solvent Curing
  3. CAN/CGSB 19.17-M90, Single component, Acrylic Emulsion Base Sealing Compound
  4. CAN/CGSB 19.13-M87, Sealing Compound, Single component, Elastomeric, Chemical Curing
  5. CAN/CGSB 19.24-M90, Multicomponent, Chemical Curing, Sealing Compound

### 1.4 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each joint sealant product indicated.
3. Informational Submittals: Provide the following submittals when requested by the Consultant:
  1. Certificates: Submit product certificates for each type of joint sealant and accessory, signed by product manufacturer certifying that materials used are appropriate for applications that they were used.

4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.5 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Manufacturer: Obtain each type of joint sealant through one source from a single manufacturer.
  2. Installer: Employ installers who are experienced with the use and application of materials specified in this Section, having experience with projects of a similar extent and complexity, and that are approved or licensed for installation of elastomeric sealants by manufacturer if required for warranty conditions.

## 1.6 SITE CONDITIONS

1. Proceed with installation of joint sealants only when the following conditions are met:
  1. Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer.
  2. Joint substrates are dry.
  3. Joint widths are within tolerances of those permitted by joint sealant manufacturer for applications indicated.
  4. Substrates are free from contaminants capable of interfering with adhesion.

## 1.7 WARRANTY

1. Installer shall provide a warranty stating that they agree to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section for a period of two (2) years from the date of Substantial Performance for the Work.
2. Manufacturers shall provide a warranty stating that they agree to provide joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section for a period of five (5) years from the date of Substantial Performance for the Work.
3. It is understood that the specified warranties exclude deterioration or failure of joint sealants arising from the following conditions:
  1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
  2. Disintegration of joint substrates from natural causes exceeding design specifications.
  3. Mechanical damage caused by individuals, tools, or other outside agents.
  4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. BASF Corporation Construction Systems
  2. Chemtron Manufacturing Ltd.
  3. C.R. Laurence of Canada
  4. Dow Corning Canada Inc.
  5. GE, Momentive Performance Materials Inc.
  6. Pecora Corporation
  7. Sika Canada Inc.
  8. Tremco Ltd.

2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Exterior Building Envelope Sealants: Provide elastomeric joint sealant products for exterior applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates or adjacent materials.
2. Interior Building Envelope Sealants: Provide joint sealant products for interior applications that establish and maintain airtight and water resistant continuous joint seals without staining or deteriorating joint substrates or adjacent materials.
3. Elastomeric Joint Sealants: Provide sealant products in accordance with ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates.
4. Latex Joint Sealants: Provide sealant products in accordance with ASTM C834, temperature Grade to suit related exposure and joint substrates, paintable, non-sag and non-staining for general application, and acoustic seals in exposed locations.
5. Acoustical Sealant for Concealed Joints: Provide sealant products in accordance with CAN/CGSB 19.21-M, ASTM C919 and ASTM E90 non-drying, non-hardening, non-skinning, non-staining, gun grade, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission. Coordinate with Section 09 29 00 – Gypsum Boards.

## 2.3 LIQUID SEALANTS

1. Type S1 – Acrylic Sealant: Single component acrylic latex, Shore A Hardness 20, conforming to CAN/CGSB 19.17-M and ASTM C834, Type OP, Grade NF.
2. Type S2 – Silicone Sealant, Mould and Mildew Resistant: Silicone based, single component, Shore A Hardness 15-25, conforming to CAN/CGSB 19.13-M, Classification C-1-40-B-N and C-1-25-B-N; and ASTM C920, Type S, Grade NS, Class 25, use NT.
3. Type S3 – Silicone Sealant: Exterior Weatherproofing Sealant: Silicone based, single component, low modulus, neutral cure, Shore A Hardness 15-25, conforming to CAN/CGSB 19.13-M, Classification C-1-40-B-N and C-1-25-B-N, and ASTM C 920, Type S, Grade NS, Class 25, use NT, M, G, A and O, colour as selected by Consultant from Standard Range.
4. Type S4 – Silicone Sealant, Structural Glazing: Not Used.
5. Type S4a – Silicone Sealant, Butt Joint Glazing: Not Used.
6. Type S5 – Interior Acoustical Sealant: Mastix type, non-skinning, non-hardening, single component synthetic rubber sealant, conforming to CAN/CGSB 19.21-M, ASTM C919 and ASTM E90.
7. Type S6 – Air Seal Sealant: Silicone based, single component, Shore A hardness 15 – 25, conforming to CGSB 19-GP-13M, classification C-1-40-B-N and C-1-25-B-N and ASTM C920, Type S, Grade NS, Class 25. Use NT, M, G, A and O.
8. Sealant Type S7 – Exterior Wall Sealant: Two-component Sealant: Chemical curing urethane, non-sag, Shore A Hardness 20-35, conforming to CAN/CGSB 19.24-M, Type 2, Class B, and ASTM C920, Type S, Grade NS, Class 25, use NT, M, and A.
9. Sealant Type S8 – Horizontal Joint Sealant: Two component, self levelling, polyurethane elastomeric conforming to CAN/CGSB 19.24M, Type 1, Class A, and ASTM C920, Type M, Grade P, Class 50, use T, M, and O.

10. Type S9 – Fuel Resistant Sealant: Not Used.
11. Type S10 – Polyurethane Sealant: Single component, non-sag, for general construction, Shore A Hardness 15+, conforming to CAN/CGSB 19.13-M, Type 2, Classification MCG-2-25-A-N and ASTM C920, Type S, Grade NS, Class 25, Use NT, M, and A.
12. Type S11 – Saw-Cut Sealants: Refer to Division 03 – Concrete.
13. Type S12 – Control Joint Sealant: Two component, solvent free, flexible epoxy-urethane, load bearing, conforming to ASTM D2240 Shore A Hardness 65-75; and ASTM C920, Type M, Grade P, Class 50, Use T.

## **2.4 PREFORMED SEALANTS**

1. Preformed Silicone Sealant System: Manufacturer's standard system consisting of pre-cured low modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral curing silicone sealant for bonding extrusions to substrates.

## **2.5 SEALANT BACKING**

1. Provide sealant backings of material and type that are non-staining, compatible with joint substrates, sealants, primers, and other joint fillers, and are approved for applications indicated by sealant manufacturer based on site experience and laboratory testing.
2. Backing Rods: Meeting requirements of ASTM C1330, Type C (closed cell material with a surface skin); Type O (open cell material); or Type B (bi-cellular material with a surface skin) and as follows:
  1. Use backing rod materials specifically recommended by joint sealer manufacturer for type of installation and materials being used.
  2. Use any of the preceding types, as approved in writing by joint sealant manufacturer for joint application indicated.
  3. Size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
  4. Non-adhering to sealant, to maintain two-sided adhesion across joint.
3. Bond Breaker Tape: Self adhesive polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where three-sided adhesion will result in sealant failure.

## **2.6 ACCESSORIES**

1. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint sealant substrate tests and site tests.
2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.
3. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

# **3 Execution**

## **3.1 EXAMINATION**

1. Examine joints indicated to receive joint sealants for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance.
2. Proceed with installation after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

1. Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
  1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  2. Clean all porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
  3. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil free compressed air.
  4. Remove laitance and form release agents from concrete.
  5. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
  6. Porous joint substrates include the following:
    1. Concrete.
    2. Masonry.
    3. Unglazed surfaces of ceramic tile.
  7. Nonporous joint substrates include the following:
    1. Metal.
    2. Glass.
    3. Porcelain enamel.
    4. Glazed surfaces of ceramic tile.
2. Prime joint substrates as recommended in writing by joint sealant manufacturer, based on pre-construction joint sealant substrate tests or prior experience:
  1. Apply primer to comply with joint sealant manufacturer's written instructions.
  2. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
3. Install backing rods at exterior locations when temperature is falling, to prevent possible out-gassing bubbles from cut or nicked surfaces of backing materials and potential for bubble formation in applied sealants.
4. Install bond breaker tapes in joints that are too shallow to allow for installation of backing rods.
5. Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears; remove tape immediately after tooling without disturbing joint seal.

### 3.3 INSTALLATION OF JOINT SEALANTS

1. Comply with joint sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
2. Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
3. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
4. Install sealant backings of type indicated to support sealants during application and at position required to produce cross sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.



1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
5. Install bond breaker tape behind sealants where sealant backings are not used between sealants and backs of moving joints.
6. Install sealants at the same time backings are installed, and as follows:
  1. Place sealants so they directly contact and fully wet joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
  4. Install sealant in such a manner as to avoid creating a concave or recessed joint.
7. Sealants: Immediately after sealant application and before skinning or curing begins, tool non-sag sealants to form smooth, uniform beads, to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint, and as follows:
  1. Remove excess sealant from surfaces adjacent to joints.
  2. Use tooling agents and profiles that are approved in writing by sealant manufacturer and that do not discolour sealants or adjacent surfaces in accordance with the figures listed in ASTM C1193 as follows:
    1. Provide concave joints in accordance with Figure 8A.
    2. Provide flush joint in accordance with Figure 8B.
    3. Provide recessed joint configuration in accordance with Figure 8C.
    4. Use masking tape to protect surfaces adjacent to recessed tooled joints.
8. Install preformed tapes in accordance with manufacturer's written instructions.

### 3.4 CLOSEOUT REQUIREMENTS

1. Cleaning: Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
2. Protecting:
  1. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Performance.
  2. Cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work if, despite protection measures, damage or deterioration occurs.

### 3.5 JOINT SEALANT SCHEDULE

1. Where no specified type of sealant is shown or specified choose one of the sealants specified in this Section applicable to that intended application, and consistent with manufacturer's recommendations.
2. Use acrylic sealant Type S1 only on the interior and only in situations where little or no movement can occur.
3. Use mould and mildew resistant silicone sealant Type S2 for non-moving joints in washrooms, and for stainless steel corner guards; do not use on floors.
4. Use silicone general construction sealant Type S3 or polyurethane sealant Type S7 and S10 for all joints, interior, and exterior, where no other specific sealant type specified; do not use on horizontal traffic joints or where immersed in water.

5. Use air seal sealant Type S6 for exterior walls only where constant or consistent air pressure difference will exist across the joint.
6. Use two component sealant Type S7 for exterior vertical joints where large movement is anticipated, not for continuous water immersion.
7. Use two component sealant Type S7 for edge joint sealant at slab edges at walls, columns, interior shaft walls and grade beams.
8. Use two component sealant Type S7, primed penetration element surfaces other than concrete, for mechanical and electrical service penetrations in concrete foundation walls and cored holes in existing tunnel. Ensure compatible material at tunnel penetrations.
9. Use two component sealant Type S8 for horizontal joint sealant of plaza, floors and decks, exterior areas only, subject to pedestrian and vehicular traffic.
10. Use two component sealant type S11 for saw-cuts in slabs on grade and horizontal joint sealant of plaza, floors and decks, interior areas only.
11. Use two component flexible epoxy sealant Type S12 for joint sealant where floor finished densified concrete or concrete with hardener are specified elsewhere in the Project Manual.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of steel doors and door frames.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process
  2. ASTM A879/A879M-22, Standard Specification for Steel Sheet, Zinc Coated by Electrolytic Process for Applications Requiring Designation of Coating Mass on Each Surface
  3. ASTM A924/A924M-22a, Standard Specification for General Requirements for Sheet Steel, Metallic Coated by Hot Dip Process
3. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 1.132-M90, Primer, Zinc Chromate, Low Moisture Sensitivity
  2. CAN/CGSB 41-GP-19Ma-78 (1984), Rigid Vinyl Extrusions for Windows and Doors
  3. CAN/CGSB 82.5-M88, Insulated Steel Doors
4. Canadian Standards Association (CSA Group):
  1. CSA W59-18, Welded Steel Construction (Metal Arc Welding)
5. Canadian Steel Door Manufacturers Association (CSDMA):
  1. Canadian Fire Labelling Guide for Commercial Steel Door and Frame Products, 2009
  2. Recommended Dimensional Standards for Commercial Steel Doors and Frames, 2000
  3. Recommended Selection and Usage Guide for Commercial Steel Door and Frame Products, 2009
  4. Recommended Specifications for Commercial Steel Door and Frame Products, 2018
  5. Recommended Specifications for Sound Retardant Steel Doors and Frames, 2006
6. 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
7. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S104-15, Standard Method for Fire Tests of Door Assemblies
  2. CAN/ULC S701.1:2022, Standard for Thermal Insulation, Polystyrene Boards
8. Intertek Testing Services/Warnock Hersey (ITS/intertek):
  1. Fire Rating Services, Building Materials and Equipment, Listings.

### **1.4 DEFINITIONS**

1. Base Metal Thickness: Thickness dimensions are minimums as defined in referenced ASTM standards for both uncoated steel sheet and uncoated base metal of metallic coated steel sheets.

2. Opening Sizes: Standard metric door sizes indicated on Drawings are considered nominal dimensions, measured from frame rabbet width and height, with allowances for nominal clearances between head, jamb, and door bottom in accordance with CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames.

#### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate throat dimensions based on actual material used for wall construction assemblies; modifications arising from substitute materials may affect throat clearance required for actual construction.

#### **1.6 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit Product data for each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, fire resistance ratings, and finishes.
3. Informational Submittals: Provide the following submittal during the course of the Work:
  1. Source Quality: Source Quality Control Submittals: Submit information on zinc coating treatment and primer spot treatment, including instructions for surface treatment before site painting and any restrictions or special coating requirements.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.7 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

#### **1.8 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Manufacturer: Obtain hollow metal doors and frames from single source of supply and from single manufacturer, and as follows:
    1. Fabricate work of this Section to meet requirements of Canadian Steel Door and Frame Manufacturer's Association, Manufacturing Specification for Doors, and Frames as minimum, and as further modified in this section.
    2. Fabricator member in good standing of Canadian Steel Door and Frame Manufacturer's Association.
  2. Supplier: Obtain hollow metal doors and frames from single source of supply and from single manufacturer.
  3. Installer: Use installers who are experienced with installation of hollow metal doors and frames of similar complexity and extent to that required for Project.
  4. Testing Agencies: Provide doors produced under label service program of testing agency acceptable to Authorities Having Jurisdiction, and as follows:
    1. Steel Fire Rated Doors and Frames: Labelled and listed by an organization accredited by Standards Council of Canada for ratings specified or indicated.
    2. Provide fire labelled frame products for those openings requiring fire protection ratings, as scheduled:

1. List by nationally recognized agency having factory inspection service and construct as detailed in Follow-up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
2. Fabricate all rated doors, frames, and screens to labelling authority standard.
3. Affix appropriate label to each opening requiring indicating labelling requirement listed, and as follows:
  1. At standard size openings: fire endurance rating.

## 1.9 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver doors and frames to project site; provide protection during transit and site storage to prevent distortion or indentation, and any additional protection required to prevent damage to finish of doors and frames and as follows:
  1. Inspect doors and frames on delivery for damage and notify shipper and supplier if damage is found.
  2. Minor damages may be repaired provided refinished items match new work and are acceptable to Consultant.
  3. Remove and replace damaged items that cannot be repaired as directed by Consultant, at no additional cost to Owner.
2. Storage and Handling Requirements: Store doors and frames at building site under cover and protected from moisture, blocked off ground and in manner to prevent sagging, bowing or twisting using wood blocking and as follows:
  1. Remove wet wrapping materials immediately upon delivery.
  2. Provide vented shelters to prevent humidity conditions that could damage door and frame finish.
  3. Provide space between stacked doors to permit air circulation.

## 1.10 SITE CONDITIONS

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where specified products are indicated to fit together with other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Established Dimensions: Establish dimensions and proceed with fabricating specified products without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for shimming and fitting.

## 2 Products

### 2.1 MATERIALS

1. Steel Sheet:
  1. Exterior Doors and Frames and Interior High Humidity Areas: Metallic coated steel sheets in accordance with ASTM A924/M924; coated to meet requirements of ASTM A653/A653M, Commercial Steel (CS), Type B, ZF120 galvanized; stretcher levelled standard of flatness where used for face sheets.
  2. Interior Doors and Frames (Normal Humidity): Electrolytic zinc coated steel sheets in accordance with ASTM A879/A879M, Commercial Steel (CS), Class B coating; mill phosphatized; suitable for unexposed applications; stretcher levelled standard of flatness.
2. Door Cores:
  1. Exterior Doors: Polystyrene rigid extruded, closed cell insulation, fire retardant treated meeting requirements of CAN/ULC S701.1, Type 4, minimum thermal resistance RSI 0.8/25 mm thickness.

2. Interior Doors: Honeycomb: Structural small cell; 25 mm maximum, kraft paper honeycomb; minimum weight 36 kg/ream; minimum density 16.5 kg/m<sup>3</sup>; sanded to required thickness.
3. Adhesives:
  1. Core Adhesive: Heat resistant, single component, polyurethane reactive (water) hot melt, thermoset adhesive.
4. Touch-Up Primer: Rust inhibitive primer meeting CAN/CGSB 1.132, touch up zinc coatings using shop applied primer; grey or red coloured primer, clear primer not acceptable; provide additional primer for site touch-up to repair damaged zinc and shop applied coatings.

## 2.2 ACCESSORIES

1. Floor anchors, channel spreaders, nominal 1.60 mm tee anchors, 1.19 mm wall stud anchors, and as follows:
  1. Hot dipped zinc coated for exterior locations.
  2. Wipe coat galvanized for interior locations.
  3. Corrugated, galvanized tee anchors or heavy gauge galvanized wire ties for masonry bond.
  4. Drill stud anchors for wire tie to studs.
  5. Lag bolts, shields and bushing for existing or concrete openings.
  6. Provide anchors appropriate to installation conditions.
2. Sealants: Refer to Section 07 92 00 – Joint Sealants.

## 2.3 DOOR FABRICATION

1. General: Fabricate steel doors rigid, neat in appearance, and free from defects including warp and buckle; 45 mm thickness of types and sizes indicated in Door Schedule on Drawings, and as follows:
  1. Door faces of all steel doors fabricated without visible seams, free of scale, pitting, coil brakes, buckles and waves.
  2. Form edges true and straight with minimum radius suitable for thickness of steel used.
  3. Bevel lock and hinge edges 3 mm in 50 mm; confirm requirement with builder's hardware or door swing that could dictate different bevel.
  4. Top and bottom of doors provided with inverted, recessed, nominal 1.60 mm steel end channels, welded to each face sheet at 150 mm o/c.
  5. Equip exterior doors with factory installed flush PVC top caps.
  6. Equip fire labelled exterior doors with factory installed flush steel top caps.
  7. Provide fire labelled doors for those openings requiring fire protection ratings, as indicated in Door Schedule on Drawings.
  8. Fabricate doors with following clearances:
    1. Clearance between door and frame and between meeting edges of doors swinging in pairs not exceeding 3 mm.
    2. Clearance between bottom of door and floor not exceeding 19 mm or as required to accommodate specified hardware.
    3. Clearance between bottom of door and raised non-combustible sill in accordance with NFPA 80.
    4. Clearance between bottom of door and nominal surface of combustible floor coverings in accordance with NFPA 80.
2. Exterior Doors: Flush, lock seam construction, insulated doors fabricated in accordance with CAN/CGSB 82.5, and as follows:
  1. Face Sheets: Minimum 1.60 mm base steel sheet thickness.
  2. Insulation Stiffened Core: Insulated and sound deadened with polystyrene core laminated under pressure to each face sheet.
  3. Longitudinal edges mechanically interlocked.

3. Interior Doors: Flush, lock seam construction, hollow steel doors fabricated in accordance with CSDMA Manufacturing Specifications for Doors and Frames, and as follows:
  1. Face sheets: Minimum 1.60 mm base steel sheet thickness.
  2. Stiffened and sound deadened with honeycomb core laminated under pressure to each face sheet.
  3. Longitudinal edges mechanically interlocked.
4. Fire Rated Doors: Flush, lock seam construction, hollow steel doors fabricated in accordance with CAN/ULC S104 and NFPA 80, and as follows:
  1. Face sheets: Minimum nominal 1.60 mm base steel sheet thickness.
  2. Stiffened and sound deadened with honeycomb core laminated under pressure to each face sheet.
  3. Longitudinal edges mechanically interlocked.
  4. Equip pairs of fire labelled doors with minimum 2.74 mm steel surface mounted flat bar astragal, welded to door face; plug welded on face and stitch welded to butt edge of door.
  5. Labelled by ULC, ITS/WH, or other testing laboratory approved by Authority Having Jurisdiction.

## 2.4 PANEL FABRICATION

1. Fabricate panels from same materials, construction and finished as doors as specified above in this Section.

## 2.5 FRAME FABRICATION

1. General: Fabricate door frames with mitred corners of frames and weld continuously along inside of frame profile, or lap and weld concealed corner plates, making exposed faces flush, mitres tight, filled, and finished smooth, and as follows:
  1. Knockdown (KD) frames are not acceptable and will be rejected.
  2. Jambs, heads, mullions, sills, and centre rails straight and uniform throughout their lengths.
  3. Factory assembled frame product square, free of defects, warps, or buckles.
  4. Accurately cope joints at mullions, transom bars, sills, or centre rails, butted and tightly fitted, with faces securely welded, matching corner joint faces.
  5. Fabricate frames in sections for site splicing where required due to site access, or when shipping limitations dictate smaller assemblies, and as follows:
    1. Provide 2.74 mm splice plates for site spliced jambs, heads, and sills, securely welded into one section, extending 50 mm minimum each side of splice joint.
    2. Site splice joints welded, filled, and ground to present smooth uniform surface after assembly is complete.
  6. Provide two (2) temporary steel jamb spreaders welded to base of jambs or mullions to maintain proper alignment during shipping and handling; remove spreaders before anchoring frame to floor.
  7. Prepare door opening for single stud door silencers, three (3) for single door openings, and two (2) for double door openings, shipped installed, coordinate with painter for removal and reinstallation after finish painting.
  8. Provide fire labelled frames for those openings requiring fire protection ratings, as indicated in Door Schedule on Drawings
2. Frames:
  1. Exterior Frames: 1.98 mm minimum, with 50 mm face standard frame profile, throat, and frame width to suit wall construction.
  2. Interior Frames: 1.60 mm minimum for single doors; 1.98 mm for frames with opening width in excess of 1220 mm, with 50 mm face standard frame profile], throat and frame width to suit wall construction.

## 2.6 DOOR HARDWARE PREPARATION

1. Prepare doors in coordination with hardware specified in Section 08 71 00 – Door Hardware and templates provided by hardware supplier, and as follows:
  1. Fully Templated Mortised Hardware: Factory blank, reinforce, drill, and tap doors.
  2. Non-Fully Templated Mortised Hardware: Factory blank and reinforce only.
  3. Surface Mounted Hardware: Factory reinforce only.
  4. Templated Holes 13 mm and Larger: Factory prepared, except mounting and through bolt holes site prepared at time of application.
  5. Templated Holes Less Than 13 mm Ø: Factory prepared only when required for function of device (for knobs, levers, cylinders, thumb or turn pieces) or when holes overlap function holes.
  6. Site drill and tap for surface mounted hardware or mortised hardware that is not fully templated at time of hardware application.
2. Hardware Reinforcement for Doors and Frames: Carbon steel, welded in place, prime painted, to the following minimum nominal thicknesses:
  1. CSDMA Recommended Specifications for Commercial Steel Door and Frame Products - Table 1: Accessories (Doors and Frames).
  2. Protect strike, reinforcement completely by guard boxes welded to frame.
3. Electronic Door Hardware Preparation: Provide templated, electrical passageways, hardware enclosures and junction boxes in accordance with manufacturer's standard requirements, and as required to maintain ULC Fire Labelling requirements, inter-connected with CSA approved conduit, passageways, and connectors:
  1. Coordinate requirements of door and frame supply for provision of shallow junction boxes supplied and installed by Division 26 – Electrical.
  2. Coordinate with hardware specified in Division 28 – Electronic Safety and Security for locations of conduit connections in doors and door frames; confirm security requirements before manufacturing hollow metal doors and frames.

## 2.7 FINISHING

1. Shop apply zinc rich primer to repair damaged zinc coatings arising from fabrication; cure primer fully before shipping to site; include compatible primer for site finishing and correction of surface abrasions to zinc coatings and factory applied primer.
2. Remove weld slag and splatter from exposed surfaces.
3. Fill and sand smooth tool marks, abrasions, and surface blemishes to present smooth uniform surfaces.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

1. Install steel doors, frames, and accessories in accordance with reviewed Shop Drawings and CSDMA Installation Guide, manufacturer's data, and as specified in this Section.
2. Door Frames:
  1. Remove temporary spreaders before installing door frames, leaving exposed surfaces smooth and undamaged.



2. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set; limit of acceptable frame distortion 2 mm out of plumb measured on face of frame, maximum twist corner to corner of 3 mm; align horizontal lines in final assembly.
3. Brace frames rigidly in position until adjacent construction is complete; install wooden spreaders at third points of frame rebate to maintain frame width, install centre brace to support head of frames 1200 mm and wider in accordance with CSDMA Installation Guide; do not use temporary metal spreaders for bracing of frames.
4. Place frames before construction of enclosing walls and ceilings allowing for deflection of adjacent construction to ensure that structural loads are not transmitted to frames, and as follows:
  1. Check and correct opening width and height, squareness, alignment, twist and plumb as frames are installed in accordance with CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames.
  2. Masonry Construction: Provide minimum of three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb.
  3. Metal Stud Partitions: Provide minimum of three wall anchors per jamb for frames up to 2150 mm high and 1 additional anchor for each 600 mm over 2150 mm high; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb; attach wall anchors to studs with screws.
  4. Remove wooden braces after frames are securely fastened or attached to adjacent construction.
5. Install studded door silencers.
6. Assemble large screens on site to provide true and even alignment with flush butt hairline jointing, all fasteners concealed.
7. Do not site weld unless approved by Consultant in writing for specific screen.
8. For frames over 1220 mm in width, provide vertical support at centre of head.
9. Coordinate grouting of all frames solid to adjacent construction.
10. Provide formed steel drip section full width of frame opening for exterior doors.
11. Fill exterior frames with foamed-in-place insulation before installation of sealants and back-up materials; coordinate with Section 07 21 19 – Foamed-in-Place Insulation.
12. Install fire rated frames in accordance with NFPA 80.
3. Frame Tolerances: Install frames to tolerances listed in CSDMA Installation Guide, and as follows:
  1. Squareness: Maximum 1.6 mm measured across opening between hinge jamb and strike jamb.
  2. Plumbness: Maximum 1.6 mm measured from bottom of frame to head level.
  3. Alignment: Maximum 1.6 mm measured offset between face of hinge jamb and strike jamb relative to wall construction.
  4. Twist: Maximum 1.6 mm measured from leading edge of outside frame rabbet to leading edge of inside frame rabbet.
4. Doors:
  1. Fit hollow metal doors accurately in frames within clearances required for proper operation, shim as necessary for proper operation.
  2. Install hardware in accordance with manufacturers' templates and instructions.
  3. Adjust operable parts for correct clearances and function.
  4. Install fire rated doors within clearances specified in NFPA 80.

### 3.3 CLOSEOUT ACTIVITIES

1. Cleaning: Clean exposed surfaces with soap and water to remove foreign matter before site touch-up.
2. Repairing: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of air-drying primer compatible with factory applied primer.

3. Protecting: Keep steel surfaces free of grout, tar or other bonding materials or sealers; clean grout or other bonding material from surfaces immediately following installation.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation stick-built aluminum framed storefronts, entrance framing, and swing doors.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. American Society for Testing and Materials (ASTM International):
  1. ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  2. ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  3. ASTM B308/B308M-20, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
  4. ASTM B429/B429M-20, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
2. Canadian Standards Association (CSA Group):
  1. CSA G40.20-13/G40.21-13 (R2023), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
  2. CSA W59.2:24, Welded Aluminum Construction

### **1.4 DEFINITIONS**

1. Equal Dimensions: Calculated dimensions for entrance system assemblies indicating equal modules aligning with in-place structural elements followed by even division of the space between structural elements; this means that entrance system materials are evenly spaced between adjacent structural members, not necessarily evenly spaced across the entire wall assembly.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Conduct a pre-construction meeting in accordance with Section 01 31 19 – Project Meetings on site to review methods and procedures related to glazed aluminum storefront systems including, but not limited to, the following:
  1. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  2. Review location and alignment of vertical and horizontal elements as they relate to the aesthetic criteria indicated on the Drawings, and the technical requirements indicated on the shop drawings.

### **1.6 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data including construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.
  2. Shop Drawings: Submit shop drawings detailing fabrication and assembly for aluminum framed entrance and storefront systems including plans, elevations, sections, details, and attachments to other work and the following:

1. Details of provisions for system expansion and contraction and for draining moisture occurring within the system to the exterior.
  2. Hardware schedule and operating hardware types, functions, quantities, and locations.
  3. Connections to adjacent air barrier membranes.
  4. Isometric drawing indicating joinery, anchorage, flashing and drainage provisions.
  5. Samples for Verification: Submit samples for verification of each type of exposed finish required in manufacturer's standard sizes for verification of colours selected for the Project.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.7 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit manufacturer's written instructions for cleaning of aluminum finishes and maintenance of operational hardware; include name of original installer and contact information in accordance with Section 01 78 23 – Operation and Maintenance Data.

#### **1.8 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by the Consultant:
  1. Installer: Use personnel experienced with the materials specified, with work of similar complexity to that indicated for the project, and who are acceptable to manufacturer.

#### **1.9 SITE CONDITIONS**

1. Site Measurements: Verify actual locations of structural supports for aluminum framed entrance and storefront systems by site measurements before fabrication and indicate measurements on Shop Drawings.
2. Established Dimensions: Establish dimensions and proceed with fabricating aluminum framed entrance and storefront systems where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions.

#### **1.10 WARRANTY**

1. Manufacturer Warranty: Provide manufacturer's standard two (2) years warranty against defects in material or workmanship and twenty (20) year warranty against failure of finishes not attributable to normal weathering starting from the date of Substantial Performance of the Work.

### **2 Products**

#### **2.1 ACCEPTABLE PRODUCTS AND MANUFACTURERS**

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Provide aluminum framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
  1. Structural loads.
  2. Thermal movements.
  3. Movements of supporting structure including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
  4. Dimensional tolerances of building frame and other adjacent construction.
2. Failure of performance requirements will be considered to include, but not be limited to, the following:
  1. Deflection exceeding specified limits.
  2. Thermal stresses transferred to building structure.
  3. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
  4. Noise or vibration created by wind and thermal and structural movements.
  5. Loosening or weakening of fasteners, attachments, and other components.
  6. Sealant failure.
  7. Failure of operating units to function properly.
3. Design Criteria:
  1. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient temperatures, accounting for surface temperatures of materials due to both solar heat gain and nighttime sky heat loss:
    1. Temperature Change (Range):
      1. Exterior Ambient: -40°C to +35°C.
      2. Interior Ambient: +16°C to +29°C.
      3. Adjust calculations to account for colour treatments or coatings on curtain wall framing members.
    2. Allow for thermal movement with no buckling of frame members, stress on glass, glazing edge seal failure, sealant failure, excess stress on curtain wall framing, anchors and fasteners, or reduction of performance.
  2. Condensation Resistance: Design thermal break to limit frosting and condensation on interior of window metal surfaces to not over 5% of area when conditions are:
    1. Exterior Air Temperature: -32°C.
    2. Interior Air Temperature: 22°C ±1.2°C.
    3. Interior Relative Humidity: N/A.
  3. Air Infiltration: Design system for maximum air leakage of 0.03 L/m<sup>2</sup> of fixed wall area when tested in accordance with ASTM E283 at a minimum static air pressure differential of 300 Pa.
  4. Water Penetration Under Static Pressure: Design system for zero water penetration when tested in accordance with ASTM E331 at a minimum differential static pressure of 20% of positive design wind load, but not less than 475 Pa.
  5. Average Thermal Conductance: Design system having average insulation factor of not more than 2.6 W/m<sup>2</sup>•K when tested in accordance with AAMA 1503.
  6. Wind Loads: 0.43 kPa, 1/50 year occurrence in accordance with the Ontario Building Code.
  7. Deflection of Framing Members:
    1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 4100 mm, and to 1/240 of clear span plus 6 mm or spans greater than 4100 mm.

2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding an amount that reduces glazing bite to less than 75% of design dimension and that reduces edge clearance between framing members and glazing or other fixed components to less than 3 mm.
3. Limit length of cantilever deflection to  $2/175$  length of the cantilevered member where framing members overhang an anchor point.

## 2.3 MATERIALS

1. Materials recommended by manufacturer for type of use and finish indicated, and as follows:
  1. Sheet and Plate: In accordance with ASTM B209/B209M, and NSI H35.1 AA1100-H14, or AA5005-H32 or H34, anodizing quality.
  2. Extruded Bars, Rods, Profiles, and Tubes: In accordance with STM B221, and ANSI H35.1 AA6063-T5 or T6, anodizing quality.
  3. Extruded Structural Pipe and Tubes: In accordance with ASTM B429/B429M, and ANSI H35.1 AA6061-T6 or AA6063-T6, anodizing quality.
  4. Structural Profiles: In accordance with ASTM B308/B308M, anodizing quality.
  5. Welding Rods and Bare Electrodes: CSA W59.2.
2. Steel Reinforcement: Coat steel with manufacturer's standard corrosion resistant primer applied immediately after surface preparation and pre-treatment, and as follows:
  1. Rolled Sheet or Strip: CSA G40.20/G40.21.
  2. Structural Shapes, Plates and Bars: CSA G40.20/G40.21.
3. Brackets and Reinforcements: Manufacturer's standard high strength aluminum with non-staining, nonferrous shims for aligning system components.
4. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials, and as follows:
  1. Use self-locking devices where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration.
  2. Reinforce members as required to receive fastener threads.
  3. Use only concealed fasteners, unless use of exposed fasteners has been accepted in writing by the Consultant.
  4. Finish exposed portions to match framing system.
  5. Use slip joint linings, spacers, and sleeves at movement joints of material and type recommended by manufacturer.
5. Anchors: Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
6. Concealed Flashing: Manufacturer's standard corrosion resistant, non-staining, non-bleeding flashing compatible with adjacent materials.
7. Framing Gaskets: As recommended by manufacturer for joint type.
8. Framing Sealants: As recommended by manufacturer for joint type.
9. Transition Membranes: manufacturer's full length recommended membrane adhering to frame profile to provide continuous air/vapour retarder to adjacent wall construction:

## 2.4 ENTRANCE FRAMES

1. Manufacturer's extruded aluminum glazed doors for manual swing operation, reinforced as required to withstand traffic conditions.
2. Exterior Door Type:
  1. Construction: Medium stile, thermally broken frame sections.

2. Dimensions: Nominal 55 mm deep with 130 mm wide vertical rails; 130 mm wide top rail; and 165 mm bottom rail, to accommodate triple insulating glazing unit (IGU) as specified in Section 08 80 00 – Glazing.
3. Glazing Method: Square stops for sealed glazing, with non-removable glazing stops on outside of door.
4. Basis-of-Design Products: Kawneer, 350T Insulpour Thermal Entrance.

## **2.5 STOREFRONT FRAMES**

1. Manufacturer's standard extruded aluminum framing members of thickness required and reinforced as required to support imposed loads.
2. Frame Type:
  1. Construction: Composite thermally broken, with glass mounted front of frame.
  2. Dimensions: Nominal 65 mm face x 150 mm deep total frame profile, with glazing throat to accommodate triple insulating glazing unit (IGU) as specified in Section 08 80 00 – Glazing.
  3. Glazing Method: Flush glazed from exterior
  4. Installation Method: Single span, storefront.
  5. Basis-of-Design Products: Kawneer, 1600UT System 1 Curtain Wall.

## **2.6 DOOR HARDWARE**

1. Manufacturer's heavy-duty hardware units in sizes and types as required to meet entrance use as indicated on Drawings, with the following opening force limitations:
  1. Egress Doors: Maximum 135 N to set door in motion and not more than 70 N to open door to minimum required width.
  2. Accessible Interior Doors: Maximum 20 N to operate door through entire range of movement.
  3. Latches and Exit Devices: Not more than 70 N required to release latch.
  4. Provide door hardware in accordance with Section 08 71 00 – Door Hardware and Door Hardware Schedule indicated on the Drawings.

## **2.7 GLAZING SYSTEMS**

1. Glass: Specified in Section 08 80 00 – Glazing.
2. Glazing Gaskets: Manufacturer's standard sealed corner pressure glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
3. Standard Glazing Sealants: As recommended by manufacturer for joint type.

## **2.8 ACCESSORIES**

1. Sprayed Insulation: As indicated in Section 07 21 19 – Foamed-in-Place Insulation.
2. Bituminous Paint: Cold applied asphalt mastic paint containing no asbestos, formulated for minimum 0.762 mm thickness per coat.

## **2.9 FABRICATION**

1. Form aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish; remove weld spatter and welding oxides from exposed surfaces by de-scaling or grinding.
3. Fabricate framing member components first, have the following characteristics when fully assembled:
  1. Sharp and straight profiles, free of defects or deformations.
  2. Accurately fitted joints with ends coped or mitred.
  3. Drainage to allow water entering joints, condensation occurring within framing members, and moisture migrating within the system to flow to the exterior.
  4. Physical and thermal isolation of glass and glazing from framing members.

5. Accommodations for thermal and mechanical movements of glass and glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
4. Fabricate storefront framing components using shear block system, screw spline system or head-and-sill receptor system with shear blocks at intermediate horizontal members to accommodate storefront loading requirements.
5. Reinforce door frames as required to support loads imposed by door operation and for installing hardware, and as follows:
  1. Provide compression weather stripping at fixed stops at exterior doors.
  2. Provide silencers at stops to prevent metal-to-metal contact at interior doors; install three silencers on strike jamb of single door frames and two silencers on head of frames for pairs of doors.
6. Reinforce entrance frames as required for installing hardware, and as follows:
  1. Provide sliding weather stripping retained in adjustable strip mortised into door edge at pairs of exterior doors.
  2. Provide weather sweeps applied to door bottoms at exterior doors.
7. Factory install hardware to the greatest extent possible; cut, drill, and tap for factory installed hardware before applying finishes.
8. Clearly mark components to identify their locations in Project in accordance with shop drawings after fabrication.

## **2.10 ALUMINUM FINISHES**

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Black Anodized Finish: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class I, AA-M10C21A44, to match Kawneer clear anodized #29.

## **3 Execution**

### **3.1 EXAMINATION**

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION - GENERAL**

1. Install storefront and entrance framing in accordance with manufacturer's written instructions using materials free from damage and having tightly fitting joints to produce hairline joints free of burrs and distortion, rigidly secured to prevent movement within joints.
2. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration; seal joints watertight except where required to allow for drainage of water from within framing system.
3. Protect aluminum against contact with concrete and dissimilar metals by painting contact surfaces with primer, by applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
4. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
5. Set continuous sill members and flashing in full sealant bed to produce weather tight installation.



6. Install components plumb and true in alignment with established lines and grades, without warp or rack.
7. Install insulation materials in accordance with Section 07 21 19 – Foamed-in-Place Insulation, framing manufacturer's requirements, and Consultant's requirements for a continuously insulated enclosure.
8. Install perimeter joint sealants in accordance with Section 07 92 00 – Joint Sealants, to produce weather tight installation.
9. Install glass in accordance with Section 08 80 00 – Glazing.

### **3.3 INSTALLATION – ENTRANCES**

1. Install entrance framing to produce smooth operation and tight fit at contact points.
2. Install exterior entrance framing to produce tight fit at weather stripping and weather tight closure.
3. Install field applied surface mounted hardware in accordance with hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

### **3.4 ERECTION TOLERANCES**

1. Install aluminum framed systems in accordance with the following maximum tolerances:
2. Location and Plane: Limit variation from true location and plane to 3 mm in 3660 mm; 6 mm over total length.
3. Alignment:
4. Limit offset from true alignment to 1.5 mm where surfaces meet in line.
5. Limit offset from true alignment to 0.8 mm where surfaces meet at corners
6. Diagonal Measurements: Limit difference between diagonal measurements to 3 mm.

### **3.5 CLOSEOUT ACTIVITIES**

1. Adjusting:
  1. Adjust operating hardware for smooth operation in accordance with hardware manufacturers' written instructions.
  2. Adjust closers designated as accessible for people with disabilities to provide a 3 second closer sweep period for doors to move from a 70° open position to 75 mm from latch measured to the leading door edge.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section includes requirements for supply and installation of commercial door hardware for the following:
  1. Swinging doors.
  2. Other doors to the extent indicated.
  3. Cylinders for doors specified in other Sections.
  4. Low energy swing door operators.
  5. Electrified door hardware.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American National Standards Institute (ANSI)/Builders Hardware Manufacturers Association (BHMA):
  1. ANSI/BHMA A156 Series
  2. ANSI/BHMA A156.18-2020, Materials and Finishes
  3. ANSI/BHMA A156.19-2019, Power Assist and Low Energy Power Operated Doors
  4. ANSI/BHMA A156.115-W-2006, Hardware Preparation in Wood Doors with Wood or Steel Frames
  5. ANSI/ICC A117.1-2017, Standard for Accessible and Usable Buildings and Facilities
3. Builders Hardware Manufacturers Association (BHMA):
  1. The BHMA Certified Products Directory (CPD)
4. Door and Hardware Institute (DHI):
  1. DHI-A115.1G, Installation Guide for Doors and Hardware
  2. Sequence and Format for the Hardware Schedule
5. National Fire Protection Association (NFPA):
  1. NFPA 80-2022, Standard for Fire Doors and Other Opening Protectives
  2. NFPA 101-2021, Life Safety Code®
6. Underwriters Laboratories of Canada (ULC):
  1. UL 228-2008, Standard for Door Closers-Holders, With or Without Integral Smoke Detectors
  2. UL 437-2013, Standard for Key Locks

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Installation Meeting: Arrange a pre-construction meeting in accordance with Section 01 31 19 – Project Meetings attended by Contractor, Subcontractor, Consultant, Owner, and Hardware Consultant to discuss the following:
  1. Keying Conference: Conduct keying conference at Project site and incorporate decisions into final keying schedule after reviewing door hardware keying system including the following:
    1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
    2. Preliminary key system schematic diagram.

3. Requirements for key control system.
  4. Address for delivery of keys.
2. Electrified Hardware Conference: Conduct pre-installation conference at project site and review methods and procedures related to electrified door hardware including the following:
  1. Review and discuss electrical roughing in and other preparatory work performed by other trades.
  2. Review sequence of operation for each type of electrified door hardware.
  3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  4. Review required testing, inspecting, and certifying procedures.
2. Coordination: Obtain and distribute templates for doors, frames, and other work specified to be factory prepared for installing door hardware and coordinate with shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware in accordance with indicated requirements, and as follows:
  1. Coordinate with Division 26 – Electrical for type of wire required for electronic hardware, schedule for installation, and connection to electronic hardware.
  2. Coordinate layout and installation of recessed pivots and closers and cast in anchoring inserts into floor construction.
  3. Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, security system, and building control system.
3. Coordinate the work of all trades, including glass and glazing, masonry, and electrical requirements covered in manufacturer's details and appropriate sections of the specifications, and as follows:
  1. Coordinate with electrical contractor to provide 120V, 60 cycle, single phase 15 Amp or 30 Amp service depending on quantity of operators, and as follows:
    1. Coordinate with electrical contractor for provision of service to each operator from junction box for multiple operators.
    2. Coordinate with electrical contractor shall provide electrical conduit and wiring from specified controls to operators as outlined on manufacturer's drawings.

## 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data indicating installation details, material descriptions, dimensions of individual components and profiles, and finishes.
  2. Shop Drawings: Submit shop drawings indicating details of electrified door hardware including the following:
    1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer installed and site installed wiring, and as follows:
      1. System schematic.
      2. Point-to-point wiring diagram.
      3. Riser diagram.
      4. Elevation of each door.
    2. Detail interface between electrified door hardware and fire alarm, access control, security, and building control system.
    3. Theory of operation for electrified hardware groups.
    4. Prepare drawings specifically for the project and submit in hard copy and CAD format:
      1. Photocopied drawings and hand reproduced drawings are not acceptable.

2. Submit separate elevations and interconnect drawings for each different electrified hardware group.
3. Hardware Schedule: Submit door hardware schedule prepared by or under the supervision of qualified Architectural Hardware Consultant (AHC), detailing fabrication and assembly of door hardware.
4. Keying Schedule: Submit keying schedule prepared by or under the supervision of qualified Architectural Hardware Consultant (AHC), detailing Owner's final keying instructions for locks, including schematic keying diagram and index each key set to unique door designations.
3. Informational Submittals: Provide the following submittals when requested by the Consultant:
  1. Certificates: Submit product certificates signed by manufacturer of door hardware certifying that products submitted comply with requirements for labelled fire doors, for types and sizes of doors used for the Project.
  2. Source Quality Control Submittals: Submit proof of participation in DHI Continuing Education Program and apply AHC stamp to completed door hardware schedule.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Provide copies of manufacturer's written maintenance information for inclusion into the operations and maintenance information in accordance with Section 01 78 23 – Operation and Maintenance Data. Indicate components that require specific handling to avoid damage to the finished Work.
2. Spare Parts and Tools: Submit unique parts and tools for maintaining hardware systems in accordance with Section 01 78 43 – Spare Parts.

#### **1.7 QUALITY ASSURANCE**

1. Regulatory Requirements:
  1. Building Code Compliance: Conform to ULC and Building Code requirements, as applicable to hardware, for labelled or rated doors and frames, and for exiting, operation and function.
  2. Manufacturing Compliance: Use only products listed in the BHMA Certified Products Directory (CPD) for hardware of this Project.
2. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Supplier: Use a door hardware supplier having warehousing facilities in Project's vicinity and employing at least one permanent staff member who is a fully certified and licensed Architectural Hardware Consultant (AHC), participating in the DHI Continuing Education Program, who will be responsible for the preparation of the door hardware schedule submittal, and as follows:
    1. Door hardware supplier shall be available during the course of the Work to consult with Contractor, Consultant, and Owner about door hardware and keying.
    2. Door hardware supplier shall have completed projects with electrified door hardware similar in material, design, and extent to that indicated for this project, and who has the capability of preparing data for electrified door hardware, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this project.
  2. Installer: Installer shall have completed door hardware similar in material, design, and extent to that indicated with a record of successful in-service performance for the last three (3) years.

## 1.8 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver hardware items in original factory containers, clearly labelling contents, and scheduled use for this project, and as follows:
  1. Inventory door hardware on receipt and provide secure lock up for door hardware delivered to Project site.
  2. Store hardware in a clean, well illuminated (500 lux minimum) securely locked storage room accessible only to authorized personnel.
2. Storage and Handling Requirements: Store hardware items on shelves; not on floors, separated and packaged as a group for each individual door with the door number, and list of items for that door on each package related to the door hardware schedule, and include basic installation instructions with each item or package, and as follows:
  1. Maintain an itemized inventory list of each item, updated on a daily basis, to show items in storage and items installed.
  2. Deliver keys to manufacturer of key control system.

## 1.9 WARRANTY

1. Provide written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
2. Failures include, but are not limited to, the following:
  1. Structural failures including excessive deflection, cracking, or breakage.
  2. Faulty operation of operators and door hardware.
  3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  4. Other failures not resulting from normal usage.
3. Warranty Period: From date of Substantial Performance, and as follows:

Hardware Type	Warranty Term
Locks, latches, and cylinders	Two (2) years
Closers	Ten (10) years
Hinges	Lifetime
Panics	One (1) year
Miscellaneous	One (1) year
Electrical Hardware:	Five (5) years

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section
2. **Substitutions: Only those products / brands listed in the attached door hardware schedule are acceptable and should be used to form a bid price. No unsolicited products will be considered. If acceptable alternates are listed here those too can be used to form a bid price provided, they are exactly the same as the specified item. If no alternates are listed, no alternate products are acceptable.**

## 2.2 PERFORMANCE REQUIREMENTS

1. Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated, and generally comply with the following provisions:
  1. Accessibility requirements in accordance with ANSI 117.1.
  2. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
  3. Door Closers: Maximum opening force requirements as follows:
    1. Interior Hinged Doors: Nominal 20 N applied perpendicular to door.
    2. Fire Doors: Minimum opening force allowable by Authorities Having Jurisdiction.
  4. Thresholds: Maximum 13 mm high; bevel raised thresholds with a slope of maximum 1:2.
  5. Latches, Locks, and Exit Devices: Nominal 65 N to release the latch, and shall not require the use of a key, tool, or special knowledge for operation.
  6. Delayed Egress Locks: Lock releases within 15 seconds after applying 90 N force.
  7. Door Closers: Nominal 130 N to set door in motion and nominal 65 N to open door to minimum required width.

## 2.3 MATERIALS

1. Materials and Finishes: Materials and finishes matching scheduled hardware, meeting requirements of BHMA A156.18, and performance required for installation.

## 2.4 ACCESSORIES

1. Automatic Swing Door Operators: Provide concealed electromechanical swing door operator, consisting of electromechanical swinging door operator and electronic control in conformance with ANSI A156.19, aluminum header, connecting hardware, and power on/off switch and safety sensor.
  1. Substitutions: Only those products / brands listed in the attached door hardware schedule are acceptable and should be used to form a bid price. No unsolicited products will be considered. If acceptable alternates are listed here those too can be used to form a bid price provided, they are exactly the same as the specified item. If no alternates are listed, no alternate products are acceptable.
2. Stainless Steel Threshold at Fire Rated Doors: Provide brushed finish stainless steel threshold at all fire rated doors as indicated on drawings.
  1. Substitutions: Only those products / brands listed in the attached door hardware schedule are acceptable and should be used to form a bid price. No unsolicited products will be considered. If acceptable alternates are listed here those too can be used to form a bid price provided, they are exactly the same as the specified item. If no alternates are listed, no alternate products are acceptable.

## 2.5 KEYING

1. Keying: Provide manufacturer's standard cores and finish face to match lockset.
2. Keying System: Provide a keying system in accordance with the following requirements:
  1. Master Key System: Cylinders are operated by a change key and a master key.
3. Keys: Provide nickel-silver keys in accordance with the following:
  1. Stamping: Permanently inscribe each key with a visual key control number and notation stating, "DO NOT DUPLICATE".
  2. Quantity: In addition to one extra blank key for each lock, provide the following:
    1. Cylinder Change Keys: Three
    2. Master Keys: Five

### 3 Execution

#### 3.1 EXAMINATION

1. Examine doors and frames, with installer present, for compliance with requirements for installation tolerances, labelled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
2. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Prepare steel doors and frames in accordance with DHI A115 Series.
2. Prepare wood doors in accordance with DHI A115-W Series.

#### 3.3 INSTALLATION

1. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required in accordance with governing regulations:
  1. Standard Steel Doors and Frames: DHI's Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
  2. Standard Wood Doors: DHI WDHS.3, Recommended Locations for Architectural Hardware for Wood Flush Doors.
2. Install each door hardware item in accordance with manufacturer's written instructions.
3. Coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 – Finishes where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way.
4. Install surface mounted items only when finishes have been completed on substrates involved, and as follows:
  1. Set units level, plumb, and true to line and location.
  2. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
  3. Drill and countersink units that are not factory prepared for anchorage fasteners.
  4. Space fasteners and anchors according to industry standards.
5. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings; verify location with Consultant, and as follows:
  1. Configuration: Provide one power supply for each door opening.
6. Thresholds:
  1. Set thresholds for acoustical doors in full bed of sealant in accordance with requirements specified in Section 07 92 00 – Joint Sealants.
  2. Set threshold for fire rated doors in full bed of epoxy adhesive.
7. Key Control System: Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.

#### 3.4 SITE QUALITY CONTROL

1. Independent Architectural Hardware Consultant: Owner may engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
2. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted, and as follows:

1. Testing: Consists of Dynamic, static and system tests.
2. Dynamic tests shall be conducted to before terminating devices to ensure door mechanics, sensors and locking devices mechanically functions correctly and free of grounds and shorts.
3. Static tests shall be conducted before interconnecting devices to ensure all equipment functions correctly when energized.
4. System tests shall be conducted to test system fully and to include fire alarm integration.

### 3.5 CLOSEOUT REQUIREMENTS

1. Adjusting:
  1. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and in accordance with referenced accessibility requirements:
    1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
    2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
    3. Door Closers: Adjust sweep period so that, from an open position of 70°, the door will take at least 3 seconds to move to a point 75 mm from the latch, measured to the leading edge of the door.
  2. Six Month Adjustment: Approximately six months after date of Substantial Performance, perform the following:
    1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
    2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
    3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.
2. Cleaning: Clean adjacent surfaces soiled by door hardware installation and as necessary to restore proper function and finish.
3. Protection: Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.
4. Demonstrating: Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

### 3.6 DOOR HARDWARE SCHEDULE

1. Refer to appended door hardware schedule and coordinate with drawing's door and hardware schedule.

**END OF SECTION**



# DOOR HARDWARE

08 71 00



PROJECT:

Niagara Regional Police  
NG911

ARCHITECT:

**AECOM**

50 Sportsworld Crossing Road  
Suite 290  
Kitchener, ON

Prepared By: Chad Connors

Date: October 23, 2024

Revised: November 12, 2024

Issued for tender Jan. 14, 2025

## Architectural Hardware Finishes

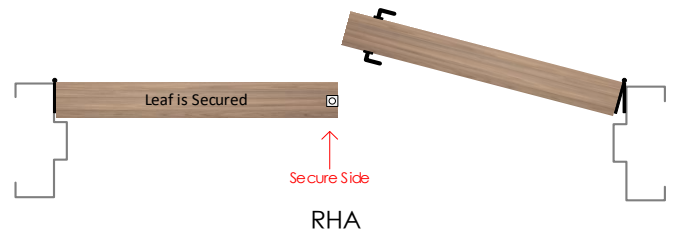
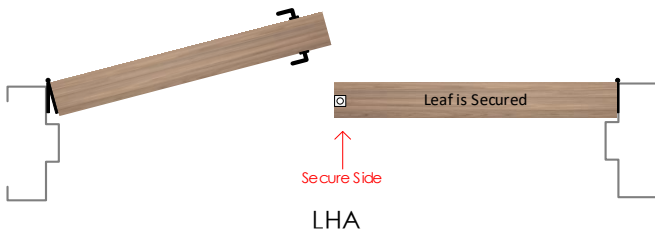
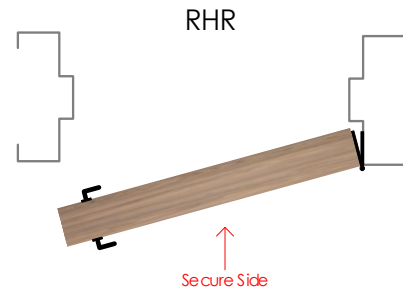
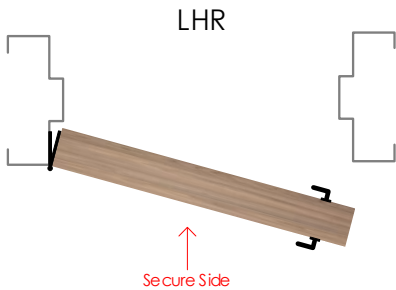
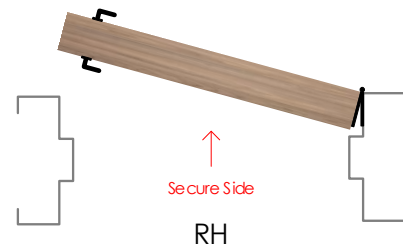
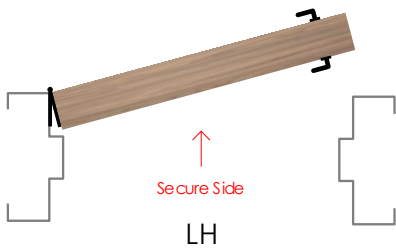
	Steel	Stainless Steel	Brass/Bronze	Aluminum	Paint/Powder Coat	US/CAN
Clear Anodized				628	689	US28
Satin Nickel	646		619	670		US15
Polished Nickel	645		618	669		US14
Satin Stainless Steel		630				US32D
Polished Stainless Steel		629				US32
Satin Chrome	652		626	702		US26D
Polished Chrome	651		625	672		US26
Satin Brass	633		606	667	678	US4
Polished Brass	632		605	666	677	US5
Satin Bronze	639		612	668	680	US10
Oil Rubbed Bronze	640		613	703	695	US10B
Flat Black / Anodized Black	631		622	671	693	US19

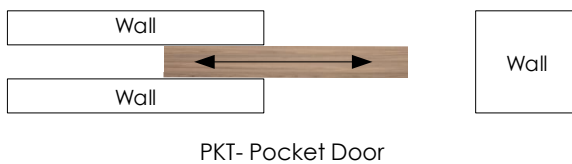
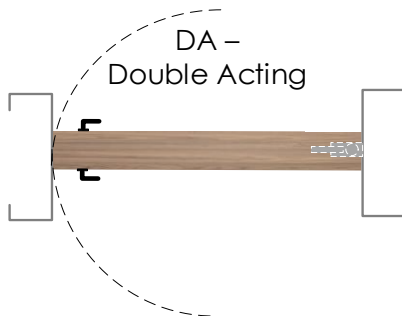
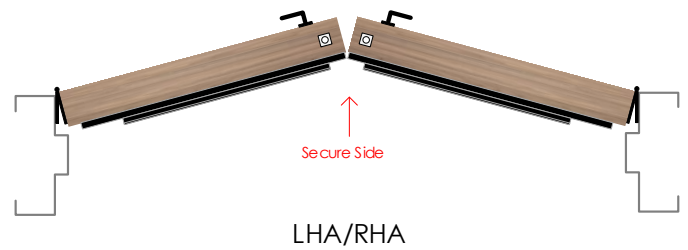
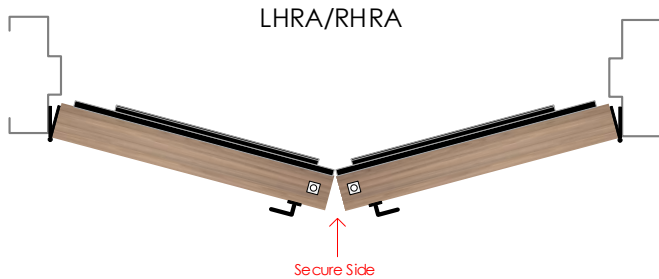
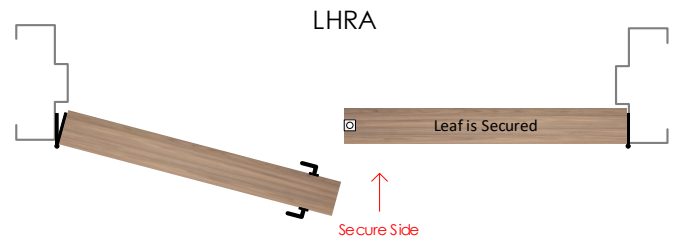
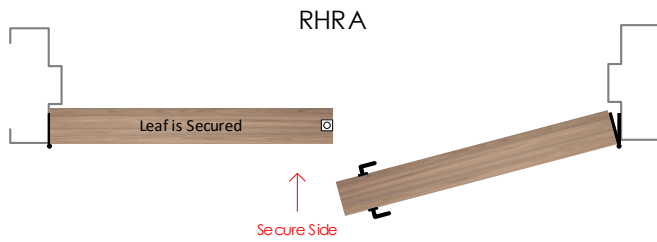
## Door Handing's

### Abbreviations

RH = Right Hand	RHA = Right Hand Active	SS = Single Slider
LH = Left Hand	LHA = Left Hand Active	BP = Bi-Parting Slider
RHR = Right Hand Reverse	RHA/LHA = Right & Left Hands Active	BF = Bi-Folding Slider
LHR = Left Hand Reverse	RHRA/LHRA = Right & Left Hand Reverse Active	TS = Telescopic Slider
RHRA = Right Hand Reverse Active	DA = Double Acting	PKT = Pocket Slider
LHRA = Left Hand Reverse Active	DE = Double Egress	

**NOTE:** The handing of a swing door is determined by placing yourself on the secured or keyed side of the door.





## Products & Alternatives

**NOTE:** Only those products / brands listed here are acceptable and should be used to form a bid price. No unsolicited products will be considered. If acceptable alternates are listed here those too can be used to form a bid price provided, they are exactly the same as the specified item. If using an alternate product to form a price it is the bidder's responsibility to ensure that product is identical in every way to the specified item. If no alternates are listed, no alternate products are acceptable.

Product Type	Product#	Manufacturer	Alternate Manufacturer 1	Alternate Manufacturer 2
Hinge	CB1900R	Best	McKinney	Ives
Flush Bolt	F65	Standard Metal	Gallery	
Power Transfer	EPT-10	Von Duprin	Securitron	Precision
Lockset	L9000	Schlage	Sargent	Dormakaba
Exit Device	98	Von Duprin	Sargent	Precision
Electric Strike	1500	HES	RCI	Von Duprin
Overhead Stop	100S	Glynn Johnson	Sargent	ABH
Door Closer	4040XP	LCN	Sargent	Dormakaba
Auto Door Operator	ED100 / ED250	Dormakaba	Besam	
Actuator	325	Camden		
Restroom Control Kit	CX-WC13AXFM	Camden		
Emergency Control kit	CX-WEC10K2	Camden		
Door Pull	3012	Standard Metal	CBH	NGP
Push Bar	6000	Standard Metal	CBH	NGP
Kick Plate	K10A	Standard Metal	CBH	NGP
Floor Stop	S101	Standard Metal	CBH	NGP
Coat Hook	P148	Standard Metal	CBH	NGP
Smoke / Sound Seal	W-66	KN Crowder	CBH	NGP
Weatherstrip	W-23	KN Crowder	CBH	NGP
Astragal	W-25	KN Crowder	CBH	NGP
Door Sweep	W-24S	KN Crowder	CBH	NGP
Relay	CX-33	Camden		

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## Symbols



- Door has a fire rating and all associated hardware must have a fire label to suit. Must comply with local requirements.



- Door is automatic and is equipped with an auto operator. Door must meet local barrier free codes



- Door has an electrical requirement and requires power to be brought to the appropriate location above the door or to the latch, for either security or barrier free applications. Refer to security & electrical drawings for further information.



- Door requires security card access. Refer to security / electrical drawings for further information.

---

## Abbreviations

### Door:

HMD = Hollow Metal Door  
IHMD = Insulated Hollow Metal Door  
ALD = Aluminum Door  
SSD = Stainless Steel Door  
ISSD = Insulated Stainless Steel Frame  
STL = Steel Door  
IC-ALD = Insulated Clad Aluminum Door  
SCWD = Solid Core Wood Door  
HCWD = Hollow Core Wood Door  
FGD = Frameless Glass Door  
FRP = Fiberglass Reinforced Plastic Door  
OHD = Overhead Door

### Frame:

HMF = Hollow Metal Frame  
ALF = Aluminum Frame  
Cased Open HMF = Cased Open Hollow Metal Frame  
SSF = Stainless Steel Frame  
STL = Steel Frame  
WDF = Wood Frame  
Cased Open WDF = Cased Open Wood Frame  
Cased Open Drywall = Cased Open Drywall

### Fire Ratings:

0 HR – Zero Hour Fire Rating / Smoke Barrier  
20 MIN – 20 Minute Fire Rating  
¾ HR – 45 Minute Fire rating  
1 ½ HR – 90 Minute Fire Rating  
2 HR – 120 Minute Fire Rating  
3 HR – 180 Minute Fire Rating

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## Disclaimer

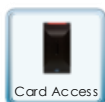
### Weblinks:

Weblinks do change from time to time as manufacturers move around their websites, please inform us if you have a none functioning weblink.



## HARDWARE SCHEDULE

Confirm IC (interchangeable core) requirements with owner – large format versus small format.  
Project written as large format.











Heading# 1

Opening Information					
Opening Type:	Pair	Opening Size:	2 - 965 x 2134 x 45	STC Rating	None
Door Material:	IHMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D101a	Location:	Exterior	From	Vestibule 101	Handing:	RHRA

By Hardware Supplier					
6	Heavy Weight Butt Hinge	CB1961R NRP 127 x 114	626 / US26D / Satin Chrome	Best	
2	Flush Bolts	F65UL	626 / US26D / Satin Chrome	Standard Metal	
1	Power Transfer	EPT-10	689 / US28 / Painted Aluminum	Von Duprin	
1	Storeroom Latch Retraction Exit Device	QEL9847NL-OP	626 / US26D / Satin Chrome	Von Duprin	
1	Rim IC Cylinder	20-057	626 / US26D / Satin Chrome	Schlage	
2	Offset Door Pull	3012-2	626 / US26D / Satin Chrome	Standard Metal	
1	Push Bar	6034-2	626 / US26D / Satin Chrome	Standard Metal	
2	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-RWPA	689 / US28 / Painted Aluminum	LCN	
1	Threshold	CT-74 x 1930	719 Milled Aluminum	KN Crowder	
1	Weatherstrip	W-23 1/1930 x 2/2134	628 / US28 / Clear Anodized	KN Crowder	
1	Astragal Set	W-25 2/2134	628 / US28 / Clear Anodized	KN Crowder	
2	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	
By Automatic Operator Supplier					
1	Auto Door Operator	ED250-SA-4x6-SGL-PUSH-NH 38-19	628 / US28 / Clear Anodized	Dormakaba	

2	Actuator	325-S/42	630 / US32D / Satin Stainless Steel	Camden	
1	Relay	CX-33		Camden	
By Security Supplier					
1	Card Reader / Keypad	By Security Provider		MFG	
1	Request to Exit	By Security Provider		MFG	
2	Door Contact	By Security Provider		MFG	
1	Power Supply	By Security Provider		MFG	
1	Access Controller	By Security Provider		MFG	
By Owner					
1	Permanent IC Core		626 / US26D / Satin Chrome	MFG	

## Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

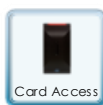
## Method of Operation

**Ingress:** Valid card/keypad authorization retracts the exit device latch allowing ingress. Alternatively, the actuator can engage the auto door operator after valid card/keypad authorization retracts the exit device latch.

**Egress:** Push exit device push pad for egress, while the request to exit sensor alerts security of an authorized exit. Alternatively, the actuator can engage the auto door operator.

-----End of Heading-----





Heading# 2

## Opening Information

Opening Type:	Pair	Opening Size:	2 - 965 x 2134 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D101b	Location:	Vestibule 101	From	Corridor 117	Handing:	RHRA

## By Hardware Supplier

6	Heavy Weight Butt Hinge	CB1961R NRP 127 x 114	626 / US26D / Satin Chrome	Best	
2	Flush Bolts	F65UL	626 / US26D / Satin Chrome	Standard Metal	
1	Dust Proof Strike	F68	626 / US26D / Satin Chrome	Standard Metal	
1	Power Transfer	EPT-10	689 / US28 / Painted Aluminum	Von Duprin	
1	Storeroom Latch Retraction Exit Device	QEL9847NL-OP	626 / US26D / Satin Chrome	Von Duprin	
1	Rim IC Cylinder	20-057	626 / US26D / Satin Chrome	Schlage	
2	Offset Door Pull	3012-2	626 / US26D / Satin Chrome	Standard Metal	
1	Push Bar	6034-2	626 / US26D / Satin Chrome	Standard Metal	
2	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-RWPA	689 / US28 / Painted Aluminum	LCN	
1	Weatherstrip	W-23 1/1930 x 2/2134	628 / US28 / Clear Anodized	KN Crowder	
1	Astragal Set	W-25 2/2134	628 / US28 / Clear Anodized	KN Crowder	
2	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	



## By Automatic Operator Supplier

1	Auto Door Operator	ED250-SA-4x6-SGL-PUSH-NH 38-19	628 / US28 / Clear Anodized	Dormakaba	
2	Actuator	325-S/42	630 / US32D / Satin Stainless Steel	Camden	
1	Relay	CX-33		Camden	

## By Security Supplier

1	Card Reader	By Security Provider		MFG	
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1	Request to Exit	By Security Provider		MFG	
2	Door Contact	By Security Provider		MFG	
1	Power Supply	By Security Provider		MFG	
1	Access Controller	By Security Provider		MFG	
By Owner					
1	Permanent IC Core		626 / US26D / Satin Chrome	MFG	

## Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

## Method of Operation

**Ingress:** Valid card authorization retracts the exit device latch allowing ingress. Alternatively, the actuator can engage the auto door operator after valid card authorization retracts the exit device latch.

**Egress:** Push exit device push pad for egress, while the request to exit sensor alerts security of an authorized exit. Alternatively, the actuator can engage the auto door operator.

-----End of Heading-----



Heading# 3

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D102	Location:	Corridor 117	To	Universal W/C 102	Handing:	LH

By Hardware Supplier					
3	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
1	Storeroom Lockset	L9080-17B x 23-030	626 / US26D / Satin Chrome	Schlage	
1	Electric Strike	1500C (fail safe)	630 / US32D / Satin Stainless Steel	HES	
2	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
1	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
1	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	
1	Coat Hook	P148	626 / US26D / Satin Chrome	Standard Metal	
By Automatic Operator Supplier					
1	Auto Door Operator	ED100-SA-4x6-SGL-PULL-NH 38-19	628 / US28 / Clear Anodized	Dormakaba	
1	Restroom Control Kit	CX-WC13AXFM	630 / US32D / Satin Stainless Steel	Camden	
1	Emergency Call System	CX-WEC10K2	630 / US32D / Satin Stainless Steel	Camden	
By Owner					
1	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	

## Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

## Method of Operation

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**Ingress:** Push door for manual ingress. Alternatively, the actuator can engage the auto door operator. Once inside the washroom the 'push to lock' actuator will engage the electric strike and disable the outside actuator. The outside actuator will change colour to indicate the washroom is in use.

**Egress:** Turn lever for manual egress. Alternatively, the actuator can engage the auto door operator.

.....End of Heading.....



Heading#

4

## Opening Information

<b>Opening Type:</b>	Single	<b>Opening Size:</b>	965 x 2134 x 45	<b>STC Rating</b>	None
<b>Door Material:</b>	HMD	<b>Frame Material:</b>	HMF	<b>Fire Rating</b>	1 1/2 HR

## 2 Total Openings

1	<b>Door#</b>	D103A	<b>Location:</b>	Corridor 117	To	Call/Dispatch 103	<b>Handing:</b>	RH
1	<b>Door#</b>	D103B	<b>Location:</b>	Corridor 117	To	Call/Dispatch 103	<b>Handing:</b>	LH

## By Hardware Supplier

6	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
2	Storeroom Lockset	L9080-17B x 23-030	626 / US26D / Satin Chrome	Schlage	
2	Electric Strike	1500C	630 / US32D / Satin Stainless Steel	HES	
4	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
2	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
2	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
2	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	

## By Automatic Operator Supplier

2	Auto Door Operator	ED100-SA-4x6-SGL-PULL-NH 38-19	628 / US28 / Clear Anodized	Dormakaba	
4	Actuator	325-S/42	630 / US32D / Satin Stainless Steel	Camden	
2	Relay	CX-33		Camden	

## By Security Supplier

2	Card Reader	By Security Provider		MFG	
2	Request to Exit	By Security Provider		MFG	
2	Door Contact	By Security Provider		MFG	
2	Power Supply	By Security Provider		MFG	
2	Access Controller	By Security Provider		MFG	

## By Owner

2	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	
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## Notes:

- 120VAC is required at the head of the door for all barrier free door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

## Method of Operation

**Ingress:** Valid card authorization releases the electric strike allowing ingress. Alternatively, the actuator can engage the auto door operator after valid card authorization releases the electric strike.










**Egress:** Turn the lever for egress, while the request to exit sensor alerts security of an authorized exit. Alternatively, the actuator can engage the auto door operator.

.....End of Heading.....

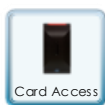
## Heading# 5

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	IHMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D103C	Location:	Exterior	From	Call/Dispatch 103	Handing:	RHR

By Hardware Supplier					
3	Heavy Weight Butt Hinge	CB1961R NRP 127 x 114	626 / US26D / Satin Chrome	Best	
1	Classroom Exit Device	98L x 996L-17-R/V	626 / US26D / Satin Chrome	Von Duprin	
1	Rim IC Cylinder	20-057	626 / US26D / Satin Chrome	Schlage	
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-RWPA	689 / US28 / Painted Aluminum	LCN	
1	Threshold	CT-74 x 965	719 Milled Aluminum	KN Crowder	
1	Weatherstrip	W-23 1/965 x 2/2134	628 / US28 / Clear Anodized	KN Crowder	
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	
By Owner					
1	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	

.....End of Heading.....



Heading#

5A

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	IHMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D112	Location:	Patio 118	From	Kitchen 112	Handing:	RHR

By Hardware Supplier					
3	Heavy Weight Butt Hinge	CB1961R NRP 127 x 114	626 / US26D / Satin Chrome	Best	
1	Classroom Exit Device	98L x 996L-17-R/V	626 / US26D / Satin Chrome	Von Duprin	
1	Rim IC Cylinder	20-057	626 / US26D / Satin Chrome	Schlage	
1	Overhead Stop	104S	630 / US32D / Satin Stainless Steel	Glynn Johnson	
1	Door Closer	4040XP-RWPA	689 / US28 / Painted Aluminum	LCN	
1	Threshold	CT-74 x 965	719 Milled Aluminum	KN Crowder	
1	Weatherstrip	W-23 1/965 x 2/2134	628 / US28 / Clear Anodized	KN Crowder	
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	
By Security Supplier					
2	Card Reader	By Security Provider		MFG	
1	Magnetic Lock	By Security Provider		MFG	
1	Pull Station	By Security Provider		MFG	
1	Door Contact	By Security Provider		MFG	
1	Power Supply	By Security Provider		MFG	
1	Access Controller	By Security Provider		MFG	
By Owner					
1	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	

## Method of Operation

**Ingress:** Valid card authorization releases the magnetic lock allowing ingress (Exit device to be in passage mode). In the event of a power loss, exit device to be in storeroom mode to secure the opening.



**Egress:** Valid card authorization releases the magnetic lock allowing egress. Loss of power or fire alarm will release the magnetic lock allowing egress. In the event of an emergency, the pull station will release the magnetic lock allowing egress.

.....End of Heading.....



Heading#

6

## Opening Information

<b>Opening Type:</b>	Single	<b>Opening Size:</b>	965 x 2134 x 45	<b>STC Rating</b>	None
<b>Door Material:</b>	HMD	<b>Frame Material:</b>	HMF	<b>Fire Rating</b>	1 1/2 HR

<b>2</b>	<b>Total Openings</b>							
1	<b>Door#</b>	D104	<b>Location:</b>	Corridor 117	To	Trainer 104	<b>Handing:</b>	LH
1	<b>Door#</b>	D105	<b>Location:</b>	Corridor 117	To	Q.A. 105	<b>Handing:</b>	RH

## By Hardware Supplier

6	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
2	Office Lockset	L9050-17B x 23-030	626 / US26D / Satin Chrome	Schlage	
2	Door Closer	4040XP	689 / US28 / Painted Aluminum	LCN	
4	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
2	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
2	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
2	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	

## By Owner

2	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	
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.....End of Heading.....

Heading#

6A

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

3	Total Openings							
1	Door#	D108	Location:	Corridor 117	To	Quiet 108	Handing:	LH
1	Door#	D113A	Location:	Corridor 117	To	Multipurpose Room 113	Handing:	RH
1	Door#	D113B	Location:	Corridor 117	To	Multipurpose Room 113	Handing:	LH


By Hardware Supplier					
9	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
3	Office Lockset	L9050-17B x 23-030	626 / US26D / Satin Chrome	Schlage	
3	Door Closer	4040XP	689 / US28 / Painted Aluminum	LCN	
6	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
3	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
3	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
By Owner					
3	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	

.....End of Heading.....

Heading# 7

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D107	Location:	Call/Dispatch 103	To	Administrator 107	Handing:	LH

By Hardware Supplier					
3	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
1	Office Lockset	L9050-17B x 23-030	626 / US26D / Satin Chrome	Schlage	
2	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
1	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
1	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
1	Coat Hook	P148	626 / US26D / Satin Chrome	Standard Metal	
By Owner					
1	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	

.....End of Heading.....

## Heading# 8

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

<b>2</b>	Total Openings							
1	Door#	D109	Location:	Corridor 117	To	W W/C 109	Handing:	RH
1	Door#	D110	Location:	Corridor 117	To	M W/C 110	Handing:	LH

By Hardware Supplier					
6	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
2	Privacy Set w/ Indicator	L9040-17B x OS-OCC	626 / US26D / Satin Chrome	Schlage	
2	Door Closer	4040XP	689 / US28 / Painted Aluminum	LCN	
4	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
2	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
2	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
2	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	
2	Coat Hook	P148	626 / US26D / Satin Chrome	Standard Metal	

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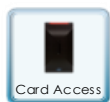
## Heading# 9

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1	Total Openings							
1	Door#	D111	Location:	Corridor 117	To	Janitor D111	Handing:	LH

By Hardware Supplier					
3	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
1	Storeroom Lockset	L9080-17B x 23-030	626 / US26D / Satin Chrome	Schlage	
1	Door Closer	4040XP	689 / US28 / Painted Aluminum	LCN	
2	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
1	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
1	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
1	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	
By Owner					
1	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	

.....End of Heading.....



Heading# 10

Opening Information					
Opening Type:	Single	Opening Size:	965 x 2134 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	3/4 HR

3	Total Openings							
1	Door#	D114	Location:	Corridor 117	To	Mech. 114	Handing:	RH
1	Door#	D115	Location:	Corridor 117	To	Elec/UPS 115	Handing:	LH
1	Door#	D116	Location:	Corridor 117	To	IT Room 116	Handing:	RH

By Hardware Supplier					
9	Standard Weight Butt Hinge	CB1900R 127 x 114	652 / US26D / Satin Chrome	Best	
3	Storeroom Lockset	L9080-17B x 23-030	626 / US26D / Satin Chrome	Schlage	
3	Electric Strike	1500C	630 / US32D / Satin Stainless Steel	HES	
3	Door Closer	4040XP	689 / US28 / Painted Aluminum	LCN	
6	Kick Plate	K10A 203 x 927	626 / US26D / Satin Chrome	Standard Metal	
3	Floor Stop	S101	626 / US26D / Satin Chrome	Standard Metal	
3	Smoke / Sound Seal	W-66 x 5233	Black	KN Crowder	
3	Door Sweep	W-24S x 965	628 / US28 / Clear Anodized	KN Crowder	
By Security Supplier					
3	Card Reader	By Security Provider		MFG	
3	Request to Exit	By Security Provider		MFG	
3	Door Contact	By Security Provider		MFG	
3	Power Supply	By Security Provider		MFG	
3	Access Controller	By Security Provider		MFG	
By Owner					
3	Permanent IC Core	By Owner	626 / US26D / Satin Chrome	MFG	

#### Method of Operation

**Ingress:** Valid card authorization released the electric strike allowing ingress.

**Egress:** Turn the lever for egress, while the request to exit sensor alerts security of an authorized exit.

.....End of Heading.....

## End of Door Hardware Schedule





## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of interior glass for doors including glazing sealants and accessories required for a complete and functional installation.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American National Standards Institute (ANSI):
  1. ANSI Z97.1-2015 (R2020), Safety Glazing Materials used in Buildings: Safety Performance Specifications and Methods of Test
3. American Society for Testing and Materials (ASTM International):
  1. ASTM C162-23, Standard Terminology of Glass and Glass Products
  2. ASTM C920-18, Standard for Elastomeric Joint Sealants
  3. ASTM C1036-21, Standard Specification for Flat Glass
  4. ASTM C1048-18, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
  5. ASTM C1376-21a, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
4. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 12.1-2017, Safety Glazing
  2. CAN/CGSB 12.8-2017, Insulating Glass Units
5. Fenestration & Glazing Industry Alliance (FGIA):
  1. FGIA Certified Products Directory
  2. IGMA TM-3000-90(16), \*North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use
  3. IGMA TM-4000-02(07), \*Insulating Glass Manufacturing Quality Procedures
6. National Glass Association (NGA):
  1. NGA's Gana Glazing Manual
  2. Engineering Standards Manual

### **1.4 DEFINITIONS**

1. Terminology: Definitions and terms for glass and glazing used in this Section are based on definitions provided in ASTM C162.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, Consultant, materials supplier(s), and other relevant personnel before commencement of Work for this Section to review methods and procedures related to glazing including, but not limited to, the following:
  1. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  2. Review temporary protection requirements for glazing during and after installation.

2. Coordination: Coordinate work of this Section with the installation of frames to ensure a continuous, uninterrupted sequence, and to prevent the undue exposure of unprotected frames to weather, and as follows:
  1. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, using reasonable tolerances.
  2. Coordinate with Section 08 41 13 – Aluminum Framed Entrances and Storefronts for edge of glass deflections based on frame limitations listed in the related requirement in accordance with referenced standards and requirements of this Section.
  3. Install glass lites only after nearby welding is completed.
  4. Mark each lite of glass as it is installed in a manner to make it visible and obvious to all persons.
  5. Do not use materials that may permanently mar, discolour, or disfigure the glass.

#### 1.6 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's technical data for each glazing material required, including installation and maintenance, and listing following properties for single and multiple glazing with comparison to specified materials with information submitted in Metric Units:
    1. Nominal USI-Factors (U-Value).
    2. Visible Light Transmittance (VLT).
    3. Specific Heat Gain Coefficient (SHGC).
    4. Shading Coefficient (SC).
    5. Relative Heat Gain (RHG).
  2. Glazing Schedule: Submit glazing schedule using same designations indicating in this Section and on Drawings listing glass types and thicknesses for size of opening and location.
  3. Samples for Verification: Submit the following samples for each glass type specified for verification by Consultant of products supplied to the Project:
    1. Monolithic Glass Units: Submit one 300 mm x 300 mm sample; of each coated glass product specified.
    2. Insulating Glass Units: Submit one fully glazed 300 mm x 300 mm sample; indicate which surfaces Low-E coatings have been applied to; attach glass performance requirements to back side of unit.
3. Informational Submittals: Provide the following submittals during the course of the Work:
  1. Low-E Certificates: Separate certification will not be required for glazing materials bearing manufacturer's permanent label designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to Authority Having Jurisdiction (AHJ), and as follows:
    1. Low-E Coatings: Submit letter indicating compliance with the specified high-performance glass coatings and glazing materials listed in this Section verifying that glass Products used for the project nominally match specified coating configuration, shading coefficient, and solar heat gain coefficient, measured at centre of glass and edge of glass.
  2. Insulating Glass Certificates: Provide certificates from manufacturer indicating tested performance requirements and proof of participation in the FGIA Certified Products and certify glass glazing compatibility for the following:

1. Compatibility between glazing materials; between insulating glass sealants, sealants, and silicones; and between gaskets, setting blocks, and similar components.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.7 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.

#### **1.8 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Source Limitations: Obtain Products from a single fabricator using glass and accessory products sourced from a single manufacturer.
  2. Fabricators: Obtain Products from fabricators acceptable to manufacturer of products proposed for use in the Work.
  3. Installers: Use glazing Subcontractors that employ personnel certified by a provincially recognized apprenticeship/journeyman/master glazier program, and that have experience with projects of similar extent and complexity required for the Project.

#### **1.9 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver packaged materials in their original containers with manufacturer's labels and seals intact and as follows:
  1. Packaging: Package glass materials to prevent damage to glass and glazing materials resulting from condensation, temperature changes and direct exposure to sun and other causes.
  2. Transportation: Comply with manufacturer's transportation requirements for protecting insulating glass units; take measures to prevent hermetic seal ruptures resulting from changes in altitude during transportation.
2. Storage and Handling Requirements: Store vertically, blocked off the floor in a weatherproof enclosure in original containers with manufacturers labels and seals intact until read for installation, and as follows:
  1. Install glass as soon as possible after delivery to site.
  2. Handle glass carefully to its place of installation.
  3. Prevent damage to glass, adjacent materials, and finished surfaces.

#### **1.10 SITE CONDITIONS**

1. Ambient Conditions: Maintain temperature, humidity, and solar exposure conditions of glass glazing materials during shipping, storage and site installation as required by manufacturer to maintain warranty and performance of installed products, and as follows:
  1. Install glazing when ambient temperature is above manufacturer's written minimum requirement and rising.
  2. Maintain ventilated environment for 24 hours after installation.
  3. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds that require curing.

### 1.11 WARRANTY

1. Manufacturer's Warranty: Manufacturer's standard form of warranty, made out to Owner and signed by glass manufacturer agreeing to replace glass units that deteriorate within the specified warranty period, commencing from date of Substantial Performance of the Work, and as follows:
  1. Coating and Seal Failure Warranty Period: Ten (10) years.

## 2 Products

### 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Glazing Manufacturers:
    1. Cardinal Glass Industries
    2. Guardian Glass
    3. Pilkington North America
    4. Schott Glass AG
    5. Viracon
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 REGULATORY REQUIREMENTS

1. Design Standard: Design glass in accordance with loads described in Part 4 of the Ontario Building Code (OBC).
2. Safety Glazing Labelling: Label safety glazing components in accordance with CAN/CGSB 12.1, applied square and aligned to glass borders, readable from interior and containing the following:
  1. Name of Glazing Company,
  2. Composition (Laminated, Laminated/Heat Strengthened or Tempered),
  3. Applicable Standards (CGSB, ANSI or ASTM),
  4. Specialty Application Marking (Appropriate to Materials),
  5. Plant Identification; and
  6. Date Code (Year-Month-Day) of Manufacture.
  7. Acceptable Substitution: Consultant may consider products meeting requirements for ANSI Z97.1 instead of CAN/CGSB 12.1, without a request for substitution.

### 2.3 MATERIALS – FLAT GLASS

1. Glass – Annealed Float: Transparent float glass manufactured in accordance with ASTM C1036, Type I, Class 1 and as follows:
  1. Glass Appearance: Ultra-Clear (Low-Iron).
  2. Glass Quality: Q3.
  3. Glass Thickness: Nominal 6 mm.
  4. Labelling: Not Required.

## 2.4 MATERIALS – HEAT-TREATED GLASS

1. Glass – Tempered Safety: Heat-treated glass manufactured in accordance with ASTM C1048 using float glass materials described above, and as follows:
  1. Glass Type: HS – Heat Strengthened.
  2. Glass Appearance: Ultra-Clear (Low-Iron).
  3. Glass Quality: Q3.
  4. Edges: Ground with no chips, cracks, or flaws; with sharp corners and edges eased and polished before heat treatment.
  5. Glass Thickness: Nominal 6 mm.
  6. Labelling: Required.

## 2.5 MATERIALS – COATED GLASS

1. Glass – Low-Emissivity (Low-E): Glass having low-emissive, metallic oxide coatings applied in accordance with ASTM C1376 using float glass materials described above, and as follows:
  1. Glass Appearance: As schedule below in this Section.
  2. Heat-Treatment: Heat strengthen or temper each lite within glass assembly in accordance with ASTM C1048 as required by glass manufacturer to prevent glass breakage arising from thermal shock.
  3. Labelling: Required.
  4. Basis-of-Design Products: Vitro Architectural Glass, Solarban 60.

## 2.6 ACCESSORIES

1. Spacer/Separator: Enhanced insulating edge spacer, thermoset foam spacer incorporating primary seal, desiccant, and secondary seal, and as follows:
  1. Basis-of-Design Products: Quanex Super Spacer TriSeal, aluminum/grey coloured.
2. Sealants for Insulating Glass Units (IGUs):
  1. Primary Seal: Polyisobutylene; colour black.
  2. Secondary Seal: Structural silicone based, conforming to ASTM C920, Type S, Grade NS, Class 25, Use NT, G and A, colour Black.
  3. Acceptable Products:
    1. SSG4000 UltraGlaze Sealant by GE.
    2. Dowsil 995 Silicone Structural Sealant by DOW.
    3. Spectrem 2 by Tremco.
3. Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.

## 2.7 FABRICATION

1. Fabrication Tolerances: Cut glass to required size allowing for proper clearances and to produce clean, straight edges with no chips, cracks, or flaws; make cut outs and openings to locations and sized indicated on Drawings, and grind edges smooth round off corners.
2. Insulating Glass Units: Fabricate insulating glass units in accordance with ASTM E2190, CANCGSB 12.8, and as required for IGMA certification in configurations indicated and as follows:
  1. Labelled Units: Label spacer bar with glass types, unit composition and spacer gas type.
  2. Stainless Steel Capillary Tube: Provide stainless steel capillary breather tubes to equalize pressure differentials between insulating glass fabricating location and insulating glass installation location when required by manufacturer; seal tube immediately prior to installation in accordance with glass fabricator's written instructions.
  3. Manufacture insulating glass units without edge channels or tape with bare glass edges.
  4. Manufacture insulating glass units with gap space having a dimension appropriate for the throat dimension of receiving glass frame system.

5. Install edge spacers so that they do not bow in or out more than 5 mm over full length of a side.

### 3 Execution

#### 3.1 EXAMINATION

1. Verification of Conditions: Verify that openings for glazing are correctly sized and within tolerance and confirm the following:
  1. Manufacturing and installation tolerances for framing system, including size, squareness and offsets at corners.
  2. Minimum required face or edge clearances.
  3. Effective sealing between joints of glass framing components.
2. Proceed with installation of glass units only after unsatisfactory conditions are corrected.

#### 3.2 PREPARATION

1. Clean and prepare glazing channels, rebates, and other framing members; confirm they are smooth and true, free of projections and that fastenings are properly set to prevent contact with glass.

#### 3.3 INSTALLATION

1. Perform glazing work in accordance with glass manufacturer's written installation requirements.
2. Monolithic: Glaze glass into framing materials in accordance with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials listed in Related Requirements and as follows:
  1. Requirements indicated within referenced glazing publications and standards that are more stringent than manufacturer's written instructions will govern in the case of conflict between this specification, manufacturer's instructions and referenced standards.
  2. Install glass plumb, true, level, and rigid.
  3. Take measures to prevent warp or twist glass to prevent stress or breaking of glass seals.
3. Insulating Glass Units (IGUs): Glaze glass into framing materials in accordance with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials listed in Related Requirements, and as follows:
  1. Requirements indicated within referenced glazing publications and standards that are more stringent than manufacturer's written instructions will govern in the case of conflict between this specification, manufacturer's instructions and referenced standards.
  2. Install glass plumb, true, level, and rigid.
  3. Take measures to prevent warp or twist glass to prevent stress or breaking of glass seals.
  4. Crimp capillary breather tube in accordance with fabricator's written instructions, and as follows:
    1. Do not trim sealant from around base of tube.
    2. Do not pull or attempt to remove the tube.
    3. Crimp tube immediately prior to installing sealed unit by placing pliers perpendicular to tube 25 mm from end of tube.
    4. Do not permit tube to be exposed to or sit in water.
    5. Cover tube with stainless steel strip and set in sealant bead compatible with insulated glass sealants.

#### 3.4 CLOSEOUT ACTIVITIES

1. Cleaning: Wash glass on both exposed surfaces in each area of Project a maximum of four (4) days in advance of site reviews leading up to Substantial Performance and written requirements for washing glass provided by glass manufacturer.

2. Protection: Protection of Glass: Protect glass from damage immediately after installation using non-staining, non-permanent or temporary coverings held away from glass surfaces and as follows:
  1. Do not apply markers to glass surface.
  2. Remove non-permanent labels and protection immediately prior to declaration of Substantial Performance.
3. Protective Measures from Adjacent Work: Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter:
  1. Remove deleterious substances immediately as recommended by glass manufacturer when contaminating substances come into contact with glass, despite provision of protective coverings.
  2. Schedule daily or weekly examination of glass surfaces adjacent to or below concrete and other masonry surfaces during the progress of construction as appropriate to construction activities, or other such time period mutually agreeable to the Consultant, Contractor and Subcontractor, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
  3. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism occurring during construction period.

### 3.5 GLASS SCHEDULES

1. Insulating Glazing Units (IGUs):
  1. Outdoor Lite: 6 mm Solarban 60 (2) on Solargray.
  2. Air Space: 12.7 mm, Air (10%) / Argon (90%).
  3. Middle Lite: 6 mm Solarban 60 (4) on Ultra-Clear.
  4. Air Space: 12.7 mm, Air (10%) / Argon (90%).
  5. Indoor Lite: 6 mm Ultra-Clear.
  6. Performance Requirements:
    1. Visible Light Transmittance: 0.28.
    2. Winter Nighttime U-Factor: 0.12 (Btu/hr\*ft<sup>2</sup>\*°F).
    3. Summer Daytime U-Factor: 0.12 (Btu/hr\*ft<sup>2</sup>\*°F).
    4. Shading Coefficient: 0.21.
    5. Solar Heat Gain Coefficient: 0.18.
    6. Outdoor Visible Light Reflectance: 0.06.

**END OF SECTION**



## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements for testing and preparation of concrete slabs to receive applied flooring products and that require additional preparation from floor flatness specified in Division 03 – Concrete to meet substrate requirements described by manufacturers of flooring finishes specified in various Division 09 – Finishes technical specifications.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM F710-22, Standard Practice for Preparing Concrete Floor to Receive Resilient Flooring
  2. ASTM F2170-19a, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
  3. ASTM F3191-23, Standard Practice for Field Determination of Substrate Water Absorption (Porosity) for Substrates to Receive Resilient Flooring
3. National Floor Covering Association of Canada (NFCA):
  1. NFCA Floor Covering Reference Manual

### 1.4 ADMINISTRATIVE REQUIREMENTS

1. Pre-Construction Meetings: Arrange for Pre-Construction Meeting in accordance with Section 01 31 19 – Project Meetings with Consultant, Contractor, Subcontractors, and suppliers affected by work of this Section to discuss installation requirements including the following:
  1. Floor Flatness: Concrete substrate flatness is within acceptable tolerances and reasonable interpretation of changes to flatness profile arising from shrinkage, curling or plastic deflection from initial measurements prepared at time of concrete placement.
  2. Condition of Substrates: Substrate conditions being acceptable to flooring manufacturer's requirements for relative humidity, mechanical bond and porosity, flatness and other conditions affecting quality of applied flooring installation.
  3. Testing Requirements: Frequency of site testing and observation reporting of flooring substrates to confirm acceptability for manufacturer's installation requirements.
  4. Best Practices: Best practices relating to workmanship and installation processes as follows:
    1. Responsibility for completion of new conditions testing performed by Contractor prior to start of Subcontractor work for this Section.
    2. Installation follow-up procedures to reduce or eliminate installation deficiencies.
    3. Sequence of work and confirmation of compatibility of installed materials and substrates.
    4. Use of trained installers for critical components.
  5. Other conditions affecting quality of installation identified during course of the Work for the project.
  6. Provide minimum 72 hours to Consultant before starting work of this Section; increase notice period when notification period spans weekends or statutory holidays.

2. Coordination: Coordinate compatibility of products specified in this Section with other product adhesive; successful implementation of flooring preparation requires input and coordination from project participants, and as follows:
  1. Consultant: Consultant provides specifications describing performance requirement for floor substrates necessary to achieve flooring manufacturers written requirements for successful installation of flooring Products.
  2. Contractor: Contractor prepares or adds content to their quality management program that includes construction actions and testing procedures that monitor floor flatness, moisture emissions and alkalinity of concrete substrates prior to installation of flooring Products and methods to ensure corrective actions recommended by third-party concrete moisture testing agency, and as directed by Consultant are implemented.
  3. Subcontractor: Subcontractor provides floor levelling and preparation described in this Section to meet flooring manufacturer's required floor flatness with thickness of underlayment based on initial concrete slab flatness measurements and reasonable interpretation of changes to slab surface flatness.

#### 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any Work of this Section:
  1. Product Data: Submit product data for products specified indicating physical properties, performance characteristics, acceptability of substrates, application limitations and required testing.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.6 QUALITY ASSURANCE

1. Installation Requirements: Install floor preparation materials and flooring products in accordance with NFCA Floor Covering Reference Manual and manufacturer's written instructions.
2. Qualifications: Provide proof of qualifications when requested by Consultant including the following:
  1. Manufacturer: Obtain specified Products through one source from a single manufacturer or using materials from a secondary source that are acceptable to the manufacturer.
  2. Installer: Install using personnel that have completed a registered floorcovering installer apprentice program or meet requirements of NFCA Trade Qualifications, and who are experienced with installation of flooring preparation Products required for the project.
3. Certifications: Provide proof of the following during the course of the Work:
  1. Compatibility Certificate: Provide letter from flooring adhesive manufacturers stating that Products proposed for use on the Project are compatible with flooring substrates, flooring preparation and flooring described throughout Division 09 – Finishes.

#### 1.7 SITE CONDITIONS

1. Ambient Conditions: Maintain air temperature and substrate temperature in accordance with manufacturer's printed installation instructions, generally between 10°C and 35°C before application and for 72 hours after application.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Ardex Americas.
  2. Custom Building Products.
  3. MAPEI Inc.
  4. Sika Canada.
  5. UZIN UTZ
  6. W.R. Meadows.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Substrate Surface Flatness Tolerances: Division 03 – Concrete establishes a flatness requirement of F<sub>F</sub>25 for slabs on grade for cast-in-place concrete and is considered as the starting flatness for work of this Section:
  1. Required Flatness: Final measurements for required flatness of substrates prior to installation of flooring materials is established by materials throughout Division 09 – Finishes.
  2. Flatness Preparation: Use patching or self-levelling screed Products described in this Section to achieve an acceptable substrate surface flatness.
  3. Final Flatness: Final flatness and level will be measured using same methods specified in Division 03 – Concrete.

### 2.3 PATCHING AND LEVELLING MATERIALS

1. Underlayment: Cementitious, self-levelling, single component, polymer modified underlayment with manufacturer's recommended primer and crack repair materials; for application thicknesses to a minimum feather edge to 13 mm.
2. Patching and Flash Patching Materials: Cementitious based, polymer modified, fine aggregate, single component, rapid curing, early strength floor patching compounds having high adhesion with manufacturer's recommended primer and surface profile; for application in thicknesses from 4 mm to 25 mm.
3. Fine Finish Flash Patching Materials: Cementitious based, polymer modified, fine aggregate, single component, ultra-fast drying, early strength floor patching compounds having high adhesion with manufacturer's recommended primer and surface profile; for application in thicknesses from 0 mm to 6 mm.

### 2.4 ACCESSORIES

1. Primer: Product compatible with and as recommended by patching and levelling Product manufacturer.

### 3 Execution

#### 3.1 EXAMINATION

1. Contractor's Pre-Installation Testing: Verify that concrete substrates are free of negative hydrostatic pressure, excessive moisture, and alkalinity by testing in accordance with ASTM F710 and ASTM F2170, and as follows:
  1. Verify that concrete floors are dry by using test methods acceptable to flooring manufacturer, and exhibit negative alkalinity, carbonization, or dusting.
  2. Verify that substrates are sound, level, free of cracks greater than 3 mm in width, and changes in elevation that may adversely affect installation.
2. Subcontractor's Verification of Conditions: Verify that concrete substrates are acceptable for installation of Products before starting any work of this Section.
  1. Verify that concrete substrates are sound and acceptable for bonding ability by measuring water absorption in accordance with ASTM F3191.
  2. Installation of Products specified in this Section will denote acceptance of site conditions.

#### 3.2 PREPARATION

1. Surface Preparation: Substrates must be structurally sound, dry, solid, and stable in accordance manufacturer's written instructions, free from dust, dirt, oil, grease, paint, curing agents, concrete sealers, latex compounds, loosely bonded toppings, loose particles, laitance, adhesive residue, and any other substance or condition that may prevent or reduce adhesion, and as follows:
  1. Fill any cracks, holes, and depressions in substrates using trowellable levelling and patching compounds.
  2. Level and patch as required for correcting floor surface finish to within flooring manufacturers tolerances for flatness based on specified floor tolerances stated throughout Division 03 – Concrete and this Section.
  3. Allow for variance from specified tolerance to account for plastic settlement of concrete slabs.
  4. Notify Consultant and Contractor when conditions are substantially different than those specified, and additional levelling materials are required to achieve specified floor flatness.

#### 3.3 UNDERLAYMENT INSTALLATION

1. Mixing: Mix in a clean mixer in accordance with manufacturer's written instructions. Use appropriate mixing and delivery method in accordance with area to receive underlayment and as follows:
  1. Periodically clean pump in accordance with manufacturer's written instructions when pump mixing is used.
  2. Do not overwater.
  3. Thoroughly mix to a homogenous, smooth, lump-free consistency.
  4. Do not overmix, which could cause air to become trapped, shortening the pot life or cause pin-holing during application and curing.
2. Application: Place Product in a ribbon pattern to achieve a continuous flow of wet material to avoid trapping air or creating a cold joint, and as follows:
  1. Set width of pour that is ideal for maintaining a wet edge throughout placement; adjust width of pour to maintain wet edge.
  2. Immediately after placing product, spread with gauge rake; smooth surface after achieving required thickness.

### **3.4 PATCHING AND FLASH PATCHING INSTALLATION**

1. Mixing: Mix in a clean container in accordance with manufacturer's written instructions and as follows:
  1. Do not overwater.
  2. Thoroughly mix with low-speed mixer to a smooth, lump-free consistency.
  3. Do not mix more material than can be applied within 8 to 10 minutes.
  4. Avoid air entrapment and prolonged mixing, which will shorten pot life.
2. Application: Use manufacturer recommended flat-edge steel trowel and as follows:
  1. Apply mixed patching and levelling Products to substrate to required thickness; to manufacturer's maximum single-coat thickness.
  2. Blend into surrounding area and finish to required smoothness.

### **3.5 CLOSEOUT REQUIREMENTS**

1. Protection:
  1. Protect from traffic dirt or dust from other trades until the final installation of the floor covering.
  2. Allow for extended periods of cure and protection when temperatures drop below 16°C or when relative humidity is higher than 70%.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements the supply and installation of interior non-structural, non-loadbearing steel stud framing system for gypsum board partitions.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Iron and Steel Institute (AISI):
  1. AISI S220-2015, North American Standard for Cold-Formed Steel Framing – Non-structural Members
3. American Society for Testing and Materials (ASTM International):
  1. ASTM A653/A653M-22, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. ASTM A792/A792M-22, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
  3. ASTM A1003/A1003M-15, Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-Coated for Cold Formed Framing Members
  4. ASTM C11-23, Standard Terminology Relating to Gypsum and Related Building Materials and Systems
  5. ASTM C645-18, Standard Specification for Nonstructural Steel Framing Members
  6. ASTM C754-20, Standard Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products
  7. ASTM C840-20, Standard Specification for Application and Finishing of Gypsum Board
  8. ASTM C1002-22, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
  9. ASTM E488/E488M-22, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
  10. ASTM E1190-21, Standard Test Methods for Strength of Powder-Actuated Fasteners Installed in Structural Members
4. National Research Council Canada (NRC):
  1. Ontario Building Code: Fire Ratings and Sound Transmission Ratings, generic listings used to establish basic performance of specified materials and assemblies on Drawings and in Specifications.
5. Canadian Sheet Steel Building Institute (CSSBI):
  1. CSSBI S18-19, Guide Specification for Non-loadbearing Steel Framing

### 1.4 DEFINITIONS

1. Standard Terminology: Refer to ASTM C11 for definitions of terms for non-structural steel stud components and gypsum board assemblies not defined in this Section or in other referenced standards.

2. Non-Structural Steel Stud Framing: Studs in this Section are intended for interior, non-loadbearing partitions except for minimal lateral loads described in this Section and are not intended to support axial loads other than self-weight and weight of attached finishes and having a core metal thickness of 0.75 mm and less, and that are governed by AISI S220.

#### 1.5 ADMINISTRATIVE REQUIREMENTS

1. Pre-Construction Meeting: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by the Contractor, Subcontractor, Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to confirm partition framing requirements and to discuss the following:
  1. Locations of reinforcing, blocking, and backing components for framing supported fixtures and accessories.
  2. Non-door openings and penetrations critical to placement of non-structural steel stud framing components.
  3. Locations of exceptions to standard 0.45 mm thickness framing members not otherwise identified in this Section.
  4. Installation of hollow metal frame assemblies into partition systems.
  5. Installation of tile finishes requiring improved framing deflection limits.
  6. Installation of seismic bracing with above ceiling work specified in other Sections.
  7. Installation of firestopping concurrent with framing work.
  8. Installation of acoustical framing components and sealants.
  9. Installation of framing work spanning building control joints.
  10. Other topics associated with coordination of work of this Section with other parts of the Work.

#### 1.6 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's height limitation tables indicating Products used for the Project confirming lateral pressure and deflection limits based on assembly type and location of partitions.
  2. Shop Drawings: Submit shop drawings indicating metal framing required for this Project, and as required below for delegated design.
3. Informational Submittals: Provide the following submittals during the course of the Work:
  1. Delegated Design Submittals for Substitutions: Submit delegated design submittals indicating details for anchorage and bracing for seismic restraint as required by the Ontario Building Code (OBC) in accordance with Section 01 35 73 – Delegated Design Procedures, and as follows:
    1. Engineering Calculations: Submit engineering calculations indicating compliance with anchorage and bracing of seismic bracing and restraint systems required by the Building Code for non-loadbearing partitions systems; sealed and signed by a professional engineer responsible for the design.
    2. Commitment to General Reviews by Architects and Engineers: Submit concurrently with Engineered Calculations.
    3. Delegated Design Submittals described above are not required for pre-engineered products specified in this Section and are only required for site fabricated systems.
  2. Pre-Engineered Seismic Bracing: Submit manufacturer's written installation instructions including list of required connectors and fasteners to building structure.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### 1.7 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver non-structural steel stud framing in tightly bundled packages, clearly marked with uncoated steel thickness using indelible ink or colour coding; materials that are bent, kinked, or twisted will not be acceptable for work of this Section.
2. Storage and Handling Requirements: Store materials flat, blocked off ground in a manner to prevent kinking or permanent deformation; keep materials having different thicknesses in separate piles.
3. Protection: Protect non-structural steel stud framing materials from corrosion, deformation and other damage during delivery, storage, and handling in accordance with AISI S202.

### 1.8 SITE CONDITIONS

1. Ambient Conditions: Maintain room, surface, and material within temperature range and for duration before, during and after application in accordance with ASTM C840 and manufacturer's written requirements.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Bailey Metal Products Ltd.
  2. ClarkDietrich.
  3. SCAFCO Steel Stud Company.
  4. Steelform Drywall Framing
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Non-Structural Steel Stud Framing Properties: Steel stud framing meeting requirements of AISI S220; having punched openings for installation of wiring and plumbing, and generally consisting of materials with nominal base steel thicknesses of 0.45 mm and 0.75 mm, and having limited performance ratings as follows:
  1. Material Yield Strength: Minimum 230 MPa.
  2. Traverse Loads (Out-of-Plane): Maximum 500 Pa.
  3. Superimposed Axial Loads (Exclusive of Gypsum Board):
    1. Maximum 1460 N/m.
  4. Superimposed Axial Loads: Maximum 890 N.
  5. Stud Thickness Based on Height and Spacing: Provide studs in lengths meeting requirements of ASTM C754 Table 3 and Table 4 as described in CSSBI S18, based on 240 Pa lateral pressure and L/240 deflection limit.
  6. Stud Thickness Exceptions: Use only 0.75 mm base steel thickness, based on 360 Pa lateral pressure and L/360 deflection limit for the following conditions:
    1. Top Tracks for Seismic Bracing: Top tracks for braced non-loadbearing partitions, remainder of framing as described in ASTM C754, Table 4.
2. Loadbearing Stud Thickness Exceptions: Use Minimum 0.84 mm base steel thickness using lateral pressure and deflection limits required by metal framing manufacturer engineer.



3. Partition Framing Fasteners: Provide manufacturer recommended fastenings and anchorages for attachment framing system to structure; meeting requirements of ASTM E488/E488M or ASTM E1190 as appropriate for type of connection and make ASTM C1002 for connections between studs and tracks using sheet metal screws; or crimping or welding in accordance with ASTM C754 at choice of installer.
4. Fire Test Response Characteristics: Coordinate with Section 09 29 00 – Gypsum Boards, use materials identical to those listed for ULC assemblies submitted to Consultant.
5. Acoustic Performance: Coordinate with Section 09 29 00 – Gypsum Boards, use materials identical assembly listings submitted to Consultant.
6. Seismic Response Characteristics: Design anchorages, bracing, restraints and other structural components of non-structural assemblies and components in accordance with the OBC, and as follows:
  1. Importance Characteristics: Provide fastenings, seismic bracing, and restraints to withstand seismic forces outlined in the OBC for Post-Disaster Importance Category.

## 2.3 MATERIALS

1. Non-Structural Steel Stud Framing Materials: Provide non-loadbearing steel stud framing members manufactured in accordance with ASTM C645, and as follows:
  1. Steel Sheet: Cold formed steel sheet or strip; press braked or roll-formed to manufacturer's standard, and meeting requirements of ASTM A1003/A1003M.
  2. Corrosion Protection: Metallic coatings in accordance with ASTM A653/A653M having Z120 minimum coating weight; or ASTM A792/A792M having AZM120 minimum coating weight as standard to manufacturer.
  3. Stud Thickness: As described above in PERFORMANCE REQUIREMENTS, based on wall height, and loading conditions.
  4. Stud Face: Nominal 32 mm.
  5. Stud Depth and Spacing: As indicated on Drawings.
2. Fabricated Steel Reinforcing: Fabricated hollow steel sections (HSS) and expansion anchors required for reinforcing support of freestanding stub walls and partitions, refer to Section 05 50 00 – Metal Fabrications.
3. Ancillary Steel Framing Materials: Provide steel channels, tracks and other framing components manufactured in accordance with ASTM C645 and AISI S220 and as follows:
  1. Steel Sheet: Cold formed steel sheet or strip; press braked or roll-formed to manufacturer's standard, and meeting requirements of ASTM A1003/A13003M.
  2. Galvanizing: Metallic coatings in accordance with ASTM A653/A653M having Z120 minimum coating weight; or ASTM A792/A792M having AZM150 minimum coating weight as standard to manufacturer.
  3. Slotted Deflection Tracks: Premanufactured slotted top runner with 63 mm downward projecting legs as follows:
    1. Slots: Nominal 6 mm wide x 38 mm high slots spaced at 25 mm O/c along length of runner
    2. Fire Rating: Tested and certified for use in fire rated partition construction and have a ULC or cULUS labelled assembly for fire rated assemblies.
    3. Acceptable Products:
      1. Slotted Stud by Bailey Metal Products .
      2. SliptrackSystems by Brady Construction Innovations.
      3. MaxTrak Slotted Deflection Track by ClarkDietrich.
      4. Slotted Track by SCAFCO.
      5. Slotted Track by Steel Form.

4. Flat Straps: Steel sheet for bracing in length and width indicated; nominal 1.2 mm core metal thickness.
5. Backing Plates: Steel sheet for blocking in length and width indicated; nominal 1.2 mm core metal thickness, or proprietary fire-retardant treated plywood backing.
6. Horizontal Cross Bracing: Nominal 1.2 mm core metal thickness; 13 mm minimum width flange x 38 mm minimum depth.
7. Carrying Channels: Nominal 1.4 mm core metal thickness with 13 mm minimum width flange x 38 mm minimum depth.
8. Clip Angles: 38 mm x 38 mm x 1.8 mm nominal core metal thickness; galvanized to match framing materials.
9. Furring Channels: Nominal 0.45 mm core metal thickness having 13 mm wide flanges and 19 mm minimum depth.
10. Hat-Shaped Channels: Nominal 0.45 mm core metal thickness having 13 mm wide flanges and 22 mm minimum depth.
11. Z-Shaped Furring: Slotted or non-slotted web based on installation condition; nominal 0.45 mm core metal thickness with 19 mm minimum attachment flanges x depth required for installation condition.
12. Resilient Furring Channels: Nominal 0.45 mm core metal thickness x 13 mm deep members designed to reduce sound transmission having asymmetrical face attached to single flange by a slotted leg (web).
13. Fasteners for Metal Framing: Type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates in accordance with ASTM C1002.

## 2.4 ACCESSORIES

1. Pre-Engineered Partition Seismic Bracing: Pre-manufactured top-of-partition seismic bracing, brace length sized to fit ceiling plenum space, and as follows:
  1. Partition Top Track: Minimum 0.75 mm core metal thickness, or as otherwise directed by manufacturer.
  2. Fastenings: Seismic bracing manufacturer's recommended self-drilling screws and attachments to structure.
  3. Basis-of-Design Products: BRACELOK RETRO by BRACELOK.
2. Preformed Top-of-Partition Firestopping Inserts for Steel Decks: Preformed, single piece mineral fibre flute inserts, cut to length and sized for steel deck profiles, for placement at top track of fire-rated partition assemblies, and as follows:
  1. Basis-of-Design Products: Hilti CP777 Speed Plugs with Hilti CFS-SP WB Firestop Joint Spray By Hilti.
3. Preformed Top-of-Partition Firestopping Inserts for Concrete Decks: Preformed, single piece polyurethane foam manufactured for placement between flat concrete slabs and top track of gypsum board partition assemblies, and as follows:
  1. Basis-of-Design Products: Hilti CFS-TTS Firestop Track Seal by Hilti.
4. Firestopping Sealants: Refer to Section 07 84 00 – Firestopping for firestopping sealants at bottom and perimeters tracks of assemblies.
5. Acoustic Sealant: Refer to Section 07 92 00 – Joint Sealants and Section 09 29 00 – Gypsum Boards.
6. Auxiliary Materials: Provide auxiliary materials required for complete installation in accordance with referenced installation standards and manufacturer's written recommendations.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Building Control Joints: Do not bridge building control and expansion joints with steel framing or furring members and as follows:
  1. Frame both sides of joints independently.
  2. Coordinate placement of movement control joint framing with Section 09 29 00 – Gypsum Boards.
2. Fire Stop Deck Inserts: Install fire resistive deck inserts and firestopping joint spray concurrently with installation where fire-resistive rated partitions are in contact with steel decking in accordance with fire stop material manufacturer's written instructions.
3. Top and Bottom of Partition Fire Stops: Install top and bottom of partition fire stops concurrently with installation of steel stud tracks where partitions are in contact with fire resistive concrete slabs in accordance with fire stop material manufacturer's written instructions.
4. Fire Rated Construction: Install materials forming a part of fire rated construction in accordance with manufacturer's instructions and as required by specific ULC listed construction requirements submitted by Contractor:
  1. Install non-loadbearing steel stud framing forming a part of fire rated gypsum partition assemblies in accordance with manufacturers ULC installation requirements.
  2. Install fire rated sealants after application of acoustic sealing materials, coordinate joint configuration with manufacturers ULC installation requirements.

#### 3.3 INSTALLATION

1. Steel Partition Framing Installation Standards: Install in accordance with steel framing manufacturer's written installation requirements and ASTM C754 and ASTM C840 requirements that apply to framing installation, and as follows:
  1. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
  2. Install foam gasket isolation strip between studs where studs are installed directly against exterior walls.
  3. Fasten to concrete with expansion anchors, shielded screws 610 mm o/c maximum.
  4. Do not use powder activated fasteners.
  5. Install steel framing and furring member so fastening surfaces vary not more than 3 mm from the plane formed by the faces of adjacent framing.
  6. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings and as follows:
    1. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
    2. Cut studs 13 mm short of full height to provide perimeter relief.
    3. Terminate partition framing at underside of floor slabs above and roof decks for full height assemblies for full height assemblies to make partitions continuous from floor to underside of solid structure.
    4. Terminate full height fire resistance rated partition framing at underside of floor slabs above and roof decks as required to maintain fire and sound resistance properties.

5. Terminate partition framing to fit tightly around structural elements, mechanical and electrical components and other members extending through partition framing.
6. Terminate partition framing at suspended ceilings for partial ceiling height assemblies.
7. Install steel studs with flanges pointing in same direction so that leading edge or end of each gypsum panel can be attached to open (unsupported) edges of stud flanges first.
8. Install horizontal cross bracing to steel studs at 1220 mm o/c vertically for the entire length of partition for unbraced walls exceeding 3660 mm in length.
2. Erection Tolerances: Install non-structural steel stud framing in accordance with ASTM C754, and as follows:
  1. Variation from Position: Maximum 3 mm offset.
  2. Variation from Plumb: Maximum 3 mm in 3000 mm.
3. Door Openings: Frame door openings using 0.80 mm core metal thickness steel studs and in accordance with gypsum board manufacturer's applicable written recommendations:
  1. Screw vertical studs at jambs to jamb anchor clips on door frame; install runner track section (for cripple studs) at head and secure to jamb studs.
  2. Install two studs at each jamb, connected for entire length.
  3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
4. Other Openings: Frame openings other than door openings the same as required for door openings and as follows:
  1. Install framing below sills of openings to match framing required above openings.
5. Supports and Ancillary Framing: Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
6. Deflection Tracks: Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement, and as follows:
  1. Isolate partition framing and wall furring where it abuts structure above.
  2. Install deflection track at head of assemblies that avoid axial loading of non-loadbearing assemblies using slotted deflection track.

### 3.4 CLOSEOUT REQUIREMENTS

1. Cleaning:
  1. Remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 23 – Final Cleaning.
2. Repairing: Repair damage to adjacent materials caused by non-structural metal framing application.
3. Protection: Protect installed products and components from damage during construction.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for design, supply, and installation of suspension systems for gypsum board ceilings.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A153/A153M-23, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. ASTM A510/A510M-20, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
  3. ASTM A641/A641M-19, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
  4. ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  5. ASTM A792/A792M-23, Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
  6. ASTM C635/C635M-22, Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
  7. ASTM C636/C636M-19, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
  8. ASTM C645-18, Standard Specification for Nonstructural Steel Framing Members
  9. ASTM C754-20, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
  10. ASTM E488/E488M-22, Standard Test Methods for Strength of Anchors in Concrete Elements
  11. ASTM E1190-21, Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate layout and installation of acoustic panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire suppression system, and partition assemblies, and as follows:
  1. Schedule and coordinate installation of ceiling to occur subsequent to completion of overhead mechanical and electrical work.
  2. Schedule and coordinate ceiling installation with mechanical and electrical trades building in components into ceiling finish panels.
  3. Schedule and coordinate removal of mechanical and electrical fixtures and accessories with qualified personnel during demolition, dismantling and removal of existing acoustical panel ceilings.

### **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified in this Section.

2. Shop Drawings: Submit reflected ceiling plans matching Drawings scale indicating ceiling penetrations and ceiling mounted components; include installation details from system manufacturer illustrating site installation requirements, and as required below for delegated design.
3. Informational Submittals: Provide the following submittals during the course of the Work:
  1. Delegated Design: Submit shop drawings indicating details for anchorage and bracing for seismic restraint as required by the Ontario Building Code (OBC) in accordance with Section 01 35 73 – Delegated Design Procedures, and as follows:
    1. Engineering Calculations: Submit engineering calculations indicating compliance with anchorage and bracing of seismic bracing and restraint systems for non-loadbearing partitions and ceiling systems; sealed and signed by a professional engineer responsible for the design.
    2. Commitment to General Reviews by Architects and Engineers: Submit concurrently with Engineered Calculations.
    3. Delegated Design Submittals described above are not required for pre-engineered products specified in this Section and are only required for site fabricated systems.
  2. Pre-Engineered Seismic Bracing: Submit manufacturer's written installation instructions including list of required connectors and fasteners to building structure.
  3. Suspended Ceiling Fastener Test Results: Submit test data indicating that fasteners and anchors used to suspend ceiling systems are sized and spaced appropriately based on suspension system manufacturer's requirements.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.6 SITE CONDITIONS

1. Ambient Conditions: Maintain room, surface, and material within temperature range and for duration before, during and after application in accordance with manufacturer's written requirements.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Suspension Systems:
    1. Armstrong Drywall Grid Systems.
    2. CertainTeed Drywall Suspension Systems.
    3. CGC Drywall Suspension Systems.
  2. Seismic Bracings:
    1. GRIDLOK by BRACELOK.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Suspended Ceiling Fasteners: Provide fasteners having a minimum capacity of 890 N in tension for vertical loading conditions, a minimum capacity of 1960 N in tension and angular and bracing conditions, and as follows:
  1. Steel Roof Decking Anchors: Attachment of suspended ceiling systems directly to steel roof decking is not permitted without written acceptance from Consultant for proposed attachment system.
  2. Steel Structure Fasteners and Concrete Steel Floor Deck Anchors: Provide attachment devices having five (5) times design load indicated in ASTM C635/C635M, Table 1, Direct Hung, having corrosion protection for Mild Service Conditions, with holes or loops for attaching hangers having capacity to sustain ceiling loads as indicated in above, selected from one of the following types:
    1. Cast-in-place anchors.
    2. Post Installed expansion anchors.
    3. Chemical anchors.
2. Seismic Response Characteristics: Design anchorages, bracing, restraints and other structural components of non-structural assemblies and components in accordance with the OBC, and as follows:
  1. Importance Characteristics: Provide fastenings, seismic bracing, and restraints to withstand seismic forces outlined in the OBC for Post-Disaster Importance Category.
3. Superimposed Loads: Determine superimposed loads applied to suspension systems by components such as light fixtures, grilles and access doors and similar components, and as follows:
  1. Hangers and Supports: Verify adequate numbers of hangers are installed to support additional loads in conjunction with normal loads of the ceiling system.
  2. Maximum Deflection: Limit deflection to L/360 in accordance with ASTM C636/C636M deflection test.
4. Structural Classification: Heavy Duty Main Beams in accordance with ASTM C635/C635M, requiring closer spacing of suspension wires in accordance with manufacturer's written installation requirements based on ceiling configuration and multiple layers of gypsum board.
5. Suspended Ceiling Hangers: Provide hanger wires, steel rods or flat bars in accordance with ASTM C754 at Contractor's choice based on weight of suspended ceiling materials, fixtures and accessories, maximum supported ceiling area in accordance with manufacturers written instructions.

## 2.3 MATERIALS

1. Suspended Gypsum Board Ceiling Grid System: Manufacturer's gypsum board suspension grid system manufactured in accordance with ASTM C635/C635M and ASTM C645, and as follows:
  1. Galvanizing: Metallic coatings in accordance with ASTM A653/A653M having Z120 minimum coating weight; or ASTM A792/A792M having AZM150 minimum coating weight as standard to manufacturer.
  2. Main Beams: Double web steel construction, minimum 0.45 mm thickness x 38 mm face flange width x nominal 43 mm high, having a knurled flange.
  3. Cross Tees: Double web steel construction, minimum 0.45 mm thickness x 38 mm face flange width x nominal 43 mm high and length to suit installation, having a knurled flange.
  4. Framing Angles: Steel construction, minimum 0.45 mm thickness x 32 mm x 32 mm with locking tabs and knurled surfaces.
  5. Transition Mouldings: Gypsum board to acoustical ceiling trims, pre-finished to match exposed Tees specified in Section 09 51 13 – Acoustical Panel Ceilings.

6. Ancillary Trims and Components: Manufacturer required furring channels, wall mouldings and edge trims, lighting trims, clips, adapters, and accessories required for complete installation.
7. Screws and Fasteners: Bugle head screws in accordance with thickness of material used and the provisions of this Section.
2. Profiled Edge Mouldings and Trim: Manufacturer's standard extruded aluminum or cold rolled steel edge mouldings and trims, including splice plates, corner pieces, gypsum board trim, attachments, and other clips.

## 2.4 ACCESSORIES

1. Tie Wire: Zinc coated steel wire, in accordance with ASTM A641/A641M Class 1, Soft Temper, 18-gauge wire.
2. Hanger Attachments to Concrete: Anchors fabricated from corrosion resistant materials with holes or loops for attaching hanger wires and capable of sustaining, without failure, a load equal to five (5) times that imposed by construction as determined by testing according to ASTM E488/E488M by a qualified independent testing agency, type of any one as follows:
  1. Cast in place anchor, designed for attachment to concrete forms, coordinate with Contractor to confirm if this is possible.
  2. Post installed, chemical anchor.
  3. Post installed, expansion anchor.
  4. Powder Actuated Fasteners: Not allowed for this project.
3. Attachment Devices: Provide anchors and fasteners meeting requirements of ASTM E488/E488M or ASTM E1190 as appropriate for type of connection, sized and spaced in accordance with performance requirements indicated above and as required by manufacturer of ceiling suspension components and as follows:
  1. Rod and Flat Hangers: Mild steel, with ASTM A653/A653M, Z120, hot dip galvanized zinc coating.
  2. Wire Hangers: Zinc coated steel wire, in accordance with ASTM A641/A641M Class 1, Soft Temper.
  3. Rod Hangers: To ASTM A510/A510M, mild carbon steel; 5 mm Ø minimum; ASTM A153/A153M, hot dip galvanized.
  4. Carrying Channels: Cold rolled, commercial steel sheet with a core metal thickness of 1.2 mm x 13 mm minimum wide flange, with ASTM A653/A653M, Z120, hot dip galvanized zinc coating; 38 mm minimum depth.
  5. Carrying Angles: Minimum 22 mm x 22 mm x 1 mm thick angles, Z275 (G90) galvanized steel sheet in accordance with ASTM A653/A653M; bolted connections using 8 mm Ø bolts.
4. Pre-Engineered Ceiling System Seismic Bracing: Pre-manufactured ceiling bracing, brace length sized to fit ceiling plenum space and acceptable to interior ceiling suspension system manufacturer as follows:
  1. Ceiling Grid: Use ceiling grid manufacturer's 2-way, heavy duty grid system and gypsum board ceiling accessories.
  2. Fastenings: Seismic bracing manufacturer's recommended self-drilling screws and attachments to structure.
  3. Basis-of-Design Products: GRIDLOK GRD-10 Series by BRACELOK.
5. Auxiliary Materials: Provide auxiliary materials in accordance with referenced installation standards and manufacturer's written recommendations.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.



2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

1. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure and verify that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength, and as follows:
  1. Provide inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction where concrete inserts are required.

### 3.3 INSTALLATION

1. Install acoustic panel ceilings in accordance with manufacturers written instructions, and as follows:
  1. Install ceiling suspension system in accordance with ASTM C636/C636M.
  2. Install ceiling suspension systems requiring seismic restraint in accordance with seismic bracing manufacturer's installation instructions.
2. Acoustic Panel Suspension System: Install acoustic panel system by suspending ceiling hangers from building's structural members, and as follows:
  1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system:
    1. Do not support ceilings directly from permanent metal forms, steel floor decking or other non-structural framing; fasten hangers to cast-in-place hanger inserts, [powder actuated fasteners,] or drilled in anchors that extend through forms and steel floor decking into concrete.
    2. Do not attach hangers to steel deck tabs; do not attach hangers to steel roof decking; attach hangers to structural members or intermediate supports.
    3. Provide additional carrier channels between structural elements where structure does not align with hangers.
    4. Do not connect or suspend steel framing from ducts, pipes, or conduit.
  2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other means that does not create a kink in the suspension wires.
  3. Install supplemental suspension members and hangers in form of trapezes or similar devices 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.
  4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns.
  5. Connect hangers directly to structure or to flat, angle, channel or rods securely fastened to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are:
    1. Secure.
    2. Appropriate for substrate.
    3. Will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  6. Space hangers at 1220 mm maximum along each member supported directly from hangers and provide hangers not more than 200 mm from ends of each member.

7. Provide additional hangers where lay-in electrical or mechanical fixtures are installed in suspension system; one at each corner with stabilizer bars to prevent overloading or rotation of the suspension members where required.
8. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
9. Do not level ceilings by putting kinks in the suspension wires.

#### **3.4 CLOSEOUT REQUIREMENTS**

1. Adjusting: Touch-up minor damage to finishes in accordance with manufacturer's instructions.
2. Repairing: Remove and replace damaged suspended ceiling components that cannot be successfully repaired.
3. Cleaning: Clean exposed surfaces of suspended ceiling system including trims, edge mouldings, and suspension system members in accordance with manufacturer's instructions.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for the supply and installation of backing boards.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing Materials (ASTM International):
  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 C11-23, Standard Terminology Relating to Gypsum and Related Building Materials and Systems
  3. ASTM C475/C475M-17(2022), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
  4. ASTM C840-20, Standard Specification for Application and Finishing of Gypsum Board
  5. 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. (0.75 mm) to 0.112 in. (2.84 mm) in Thickness
  6. ASTM C1178/C1178M-18, Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing board
  7. ASTM D3273-21, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
3. Gypsum Association (GA):
  1. GA-238-2019, Guidelines for Prevention of Mould Growth on Gypsum Board
  2. GA-600-2021, Fire Resistance Design Manual

### **1.4 DEFINITIONS**

1. Refer to ASTM C11 for definitions of terms for gypsum board and related building materials not defined in this Section or in other referenced standards.

### **1.5 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

### **1.7 SITE CONDITIONS**

1. Ambient Conditions: Maintain rooms, surfaces, and materials within required temperature range before, during and after application in accordance with ASTM C840 and manufacturer's written requirements.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. CertainTeed Gypsum of Canada.
  2. CGC Interiors, A USG Company.
  3. Georgia-Pacific Canada, Inc
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Backing Board Sizes: Provide backing boards in maximum lengths and widths available that minimize joints in each area and correspond with support system as indicated on Drawings, with long edges tapered and using thicknesses indicated on Drawings.

### 2.3 MATERIALS

1. Gypsum Backer Boards: Glass mat faced gypsum board meeting requirements of ASTM C1178/C1178M with mould resistant facers meeting a rating of 10 (zero mould growth) in accordance with ASTM D3273, and as follows:
  1. Acceptable Products:
    1. CertainTeed, Diamondback GlasRoc Tile Backer.
    2. CGC, Durock Glass-Mat Tile Backerboard.
    3. Georgia-Pacific, DensShield Tile Backer.

### 2.4 ACCESSORIES

1. Steel Self-Drilling Screws: Self-drilling screws in accordance with ASTM C954 for fastening backing boards to steel members from 0.80 mm to 2.67 mm nominal core metal thickness, and as follows:
  1. Type S: Shallow pitch screw; used for single layer backing board application.
2. Joint Tape: Joint tape meeting requirements of ASTM C475/C475M, Type as recommended by backing board manufacturer for type of installation; use only mould resistant materials.
3. Joint Compound: Mould resistant joint compound and accessory materials in accordance with ASTM C475/C475M; for each coat use formulation that is compatible with other compounds applied on previous or for successive coats and as follows:
  1. Pre-Filling: Setting type joint compound.
  2. Embedding and First Coat: Setting type joint compound.
4. Sealants: Refer to Section 07 92 00 – Joint Sealants.

## 3 Executions

### 3.1 EXAMINATION

1. Verify that partition components, substrates and framing, and other conditions affecting installation are satisfactory before starting installation.
  1. Proceed with installation only after unsatisfactory conditions are corrected.

### 3.2 PREPARATION

1. Mould Prevention: Do not install gypsum-based backing boards that are wet, that have been damaged by moisture, or that have evidence of mould growth such as fuzzy surfaces or dark splotchy surfaces and discolouration:
  1. Keep backing boards dry throughout installation.
  2. Do not install backing boards over other building materials where conditions exist that are favourable to mould growth.
  3. Install backing boards installed on walls with a minimum 6 mm gap between bottom edge of board and floor surface.

### 3.3 INSTALLATION

1. Movement Control Joints: Form control joints to account for thermal movements, to account for movement where direction of framing changes direction, and movements arising differing substrate materials using V-Shaped trims by framing back-to-back framing members and a break in backing boards at a maximum of 7.5 metres o/c, as follows:
  1. Install control joints in partition construction in accordance with ASTM C840 so that gross area enclosed by joints does not exceed 80 m<sup>2</sup> between joints with a maximum single dimension between joints of 9 metres.
  2. Lay out control joints to coincide as far as possible with door, window, or screen frames, but not necessarily to occur at every individual frame; install control joints vertically and horizontally from corners of openings.
  3. Provide continuous dust barrier behind joints.
  4. Install joints straight and true.
  5. Form control joints to meet sound rated construction and fire ratings required for remainder of partition construction.
  6. Obtain Consultant's acceptance of control joint layout before starting installation of materials specified in this Section.
2. Install backing boards in accordance with ASTM C840 and manufacturer's written instructions, and as follows:
  1. Install backing boards to produce a flat surface; shim surfaces to produce a uniform plane across backing board surfaces where tile backing boards abut other types of panels in the same plane.
  2. Single Layer Application:
    1. On partitions, apply backing boards horizontally to minimize end joints.
    2. Stagger abutting end joints not less than one framing member in alternate courses of board.
    3. Apply backing boards to supports using Type S screws fastened 10 mm from edges of board with screws long enough to penetrate 10 mm into metal stud framing.

### 3.4 CLOSEOUT REQUIREMENTS

1. Adjusting: Repairs: Touch-up minor damage to backing boards in accordance with manufacturer's instructions; remove and replace backing boards that cannot be successfully repaired.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section includes requirements for the supply and installation of gypsum boards forming part of interior wall framing assemblies.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing Materials (ASTM International):
  1. ASTM A653/A653M-22, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. ASTM C11-18b, Standard Terminology Relating to Gypsum and Related Building Materials and Systems
  3. ASTM C475/C475M-17(2022), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
  4. ASTM C645-18, Standard Specification for Non-structural Steel Framing Members
  5. ASTM C834-17(2023), Standard Specification for Latex Sealants
  6. ASTM C840-20, Standard Specification for Application and Finishing of Gypsum Board
  7. ASTM C919-22, Standard Practice for Use of Sealants in Acoustical Applications
  8. ASTM C954-18, 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
  9. ASTM C1002-20, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
  10. ASTM C1396/C1396M-17, Standard Specification for Gypsum Board
  11. ASTM C1658/C1658M-19, Standard Specification for Glass Mat Gypsum Panels
  12. ASTM D3273-21, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
3. Gypsum Association (GA):
  1. GA-214-2017, Quick Reference Guide Levels of Finish
  2. GA-216-2018, Application and Finishing of Gypsum Panel Products
  3. GA-223-2017, Gypsum Panel Products, Types, Uses, Sizes, and Standards
  4. GA-238-2019, Guidelines for Prevention of Mold Growth on Gypsum Board
4. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S101-14, Standard Methods of Fire Endurance Tests of Building Construction and Materials
  2. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  3. CAN/ULC S114:2018, Standard Method of Test for Determination of Non-Combustibility in Building Materials
  4. CAN/ULC S702.1-14 (R2019), Standard for Mineral Fibre Thermal Insulation for Buildings
  5. Underwriters' Laboratories of Canada (ULC), List of Equipment and Materials

### 1.4 DEFINITIONS

1. Refer to ASTM C11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

2. Levels of Finish: Standard levels of finish defined by GA Manual apply to products of this Section as follows, and are used to designate required finish levels for indicated areas:
  1. Level 0: Not Used.
  2. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, unless a higher level of finish is required for fire resistance rated assemblies and sound rated assemblies.
  3. Level 2: Not Used.
  4. Level 3: Not Used.
  5. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view.
  6. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat over entire surface for corridors, long hallways, walls, and ceilings having a length greater than 7500 mm or walls higher than 3600 mm.

### 1.5 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified.
3. Informational Submittals: Provide following submittals during the course of the Work:
  1. Fire Rating Product Data: Submit manufacturer's product data indicating compliance with deflection, loading and fire resistance ratings a minimum of thirty (30) working days before starting work of this Section, and as follows:
    1. Not later than thirty (30) working days following Award of Contract, submit copies of ULC Assembly and Materials Listing, Fire Resistance indicating ULC Number of assemblies used for work of this Section; indicate proof of compliance for rating criteria and assemblies listed on drawings meeting requirements of Appendix D of National Building Code for review by the Consultant.
    2. ULC Listings indicated on Drawings indicate Basis-of-Design only and are not intended to provide a final solution; Substitutions will be considered for ULC Assemblies incorporating different manufacturer's materials and that are compliant with the Fire Ratings demonstrated by the listing indication on the Drawings.
    3. Use the same system and material as would be required for a tested assembly for the project; ULC Listings are tested with the specific materials indicated; substitutions will not be permitted unless evidence of equivalency is confirmed.
    4. Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site; include manufacturer's printed instructions for installation.
    5. Submit manufacturer's engineered judgement for assemblies that are modified from published ULC Assembly and Materials Listings in accordance with Section 07 05 53 – Fire and Smoke Assembly Identification.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### 1.6 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

## 1.7 QUALITY ASSURANCE

1. Regulatory Requirements: Fire-resistance ratings described on the Drawings and within this Section are based on material contributions listed in the Building Code; provide materials and construction identical to those described in the listed assemblies, or provide proof of performance as evidenced through an independent testing and inspection agency for materials that differ showing identical or better performance acceptable to the Authorities Having Jurisdiction as follows:
  1. Fire-Resistance Rated Assemblies: Provide submittals for assembly solutions using manufacturer's proprietary Products.
  2. Performance Requirements: Use only Products that form a part of a fire-resistance rated assembly tested and listed in accordance with assemblies described.
  3. Acceptable Substitutions: Type X Products specified in this Section can be substituted by Type C Products when supported by manufacturer specific ULC Assembly and Materials Listing is submitted to the Consultant prior to starting work of this Section.
  4. Whole System Compliance: Products installed on site and forming a ULC Listed Assembly must match tested assembly; mixing of different manufacturer's Products from those described in the ULC Listed Assembly will not be permitted unless accompanied by an Engineering Judgement from all manufacturers providing Products to the assembly in accordance with Section 07 05 53 – Fire and Smoke Assembly Identification.

## 1.8 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance: Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier:
  1. Deliver gypsum board to site as near to the time of installation as possible.
  2. Protect gypsum board from damage during transportation using weather tight coverings.
  3. Remove shipping coverings once load is delivered and move to dry storage location.
2. Storage and Handling: Store materials inside under cover and kept dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes:
  1. Protect gypsum board from water, condensation, and other forms of moisture.
  2. Stack gypsum panels flat and on sufficient spacers to prevent sagging, and not in direct contact with floor surfaces.
3. Protection from Mould and Mildew: Protect gypsum board from conditions that have probability of inoculating or causing mould growth during transportation and delivery, storage and handling, and installation in accordance with Gypsum Association GA-238.

## 1.9 SITE CONDITIONS

1. Ambient Conditions: Maintain room, surface, and material within temperature range and for duration before, during and after application in accordance with ASTM C840 and manufacturer's written requirements.

## 2 PRODUCTS

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. CertainTeed Gypsum of Canada.
  2. CGC Interiors, A USG Company.
  3. Georgia-Pacific Canada, Inc.



2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Gypsum Board Sizes: Provide gypsum boards in maximum lengths and widths available that minimize joints in each area and correspond with support system as indicated on Drawings, with long edges tapered and using thicknesses indicated on Drawings.
2. Fire Test Response Characteristics: Refer to Section 07 05 53 – Fire and Smoke Assembly Identification; use materials identical to those listed for ULC assemblies submitted to Consultant for information submittals.
3. Mould Resistance: Gypsum Board tested in accordance with ASTM C1396 must have mould resistant facers meeting a rating of 8 or better, showing a maximum of 20% growth based on surface area coverage in accordance with ASTM D3273.

## 2.3 MATERIALS

1. Panel Sizes: Provide gypsum panels in maximum lengths and widths available that minimize joints in each area and correspond with support system as indicated on drawings, with long edges tapered and using thicknesses indicated on Drawings.
2. Gypsum Core: Provide gypsum panels having gypsum core manufactured from recycled gypsum from post-industrial and post-consumer sources, and synthetic gypsum sourced from flue-gas desulphurization to the greatest extent possible to minimize use of natural (mined) gypsum.
3. Gypsum Panels: Provide in maximum lengths and widths available that minimize joints in each area and correspond with support system as indicated on Drawings, in thicknesses as indicated and as follows:
  1. Regular Gypsum Board: In accordance with ASTM C1396/C1396M with long edges tapered; in thickness as indicated on Drawings, and as follows:
    1. Acceptable Products:
      1. Regular Gypsum Board by CertainTeed.
      2. Sheetrock Gypsum Panels by CGC.
      3. ToughRock Gypsum Board by Georgia-Pacific.
    2. Fire Resistant Gypsum Board: In accordance with ASTM C1396/C1396M and having maximum surface burning characteristics of FS-25/SD-5 in accordance with CAN/ULC S102, with long edges tapered; in thickness as indicated on Drawings, and as follows:
      1. Acceptable Products:
        1. CertainTeed Type-X Gypsum Board by CertainTeed.
        2. Sheetrock Firecode X by CGC.
        3. Toughrock Fireguard X by Georgia-Pacific.
      3. Span-Rated Ceiling Gypsum Board: In accordance with ASTM C1396/C1396M, manufactured to provide better sag resistance than regular gypsum board, and as follows:
        1. Acceptable Products:
          1. Easi-Lite Interior Ceiling Board by CertainTeed.
          2. Ultralight Interior Ceiling Board by CGC.
          3. ToughRock Span 24 Ceiling Board by Georgia-Pacific.
        4. Acoustically Rated Gypsum Board: Meeting requirements of ASTM C1396/C1396M with acoustical dampening polymer interlayer, and as follows:

1. Assembly: Use materials that provide acoustic performance equal to or better than wall assemblies listed on Drawings.
2. Fire Rating: Use Type-X acoustically rated gypsum board when assembly requires fire rating.
3. Acceptable Alternative Products: Use any of the following acoustically rated products instead of regular or fire-resistant gypsum board listed above at Contractor's choice, provided that supporting information is submitted showing acceptable acoustic and fire-resistance performance required for the project:
  1. SilentFX QuickCut Drywall by CertainTeed.
  2. QuietRock EZ-Snap by PABCO Gypsum.

## 2.4 ACCESSORIES

1. Acoustic Sealants for Fire Rated Assemblies: Use only fire rated materials as final seal in fire rated assemblies; apply acoustic sealants prior to application of fire seals; refer to Section 07 84 00 – Firestopping for fire seal materials.
2. Acoustic Sealants for Smoke Rated Assemblies: Lightweight low trigger resistance, non-sag, smooth surface finishing smoke and acoustic sealant in accordance with ASTM C834 and as follows:
  1. Basis-of-Design Products: Hilti, CP 506 Smoke and Acoustic Sealant.
3. Acoustic Insulation for Fire and Smoke Rated Assemblies: Meeting the requirements of ULC S702.1 mineral fibre acoustic sound batts, Type 1 for all properties except thermal performance, width to friction fit steel studs; un-faced, nominal thickness as required to fill minimum 90% of the cavity width, nominal density 40 kg/m<sup>3</sup> minimum; STC ratings as indicated on drawings; having maximum flame spread and smoke developed of 0/0 in accordance with CAN/ULC S102 and being non-combustible in accordance with CAN/ULC S114, and as follows:
  1. Acceptable Products:
    1. MinWool Sound Attenuation Fire Batts (SAFB) by Johns Manville.
    2. Thermafiber Fire & Sound Guard by Owens Corning.
    3. AFB by ROCKWOOL.
4. Acoustic Insulation for Non-Rated Assemblies: Meeting the requirements of ASTM C423, ASTM E90 and ASTM E413, and ULC S702.1 glass fibre acoustic sound batts, Type 1 for all properties other than thermal, width to friction fit steel studs; un-faced, nominal thickness as required to fill minimum of 90% of the cavity width, nominal density 12.2 kg/m<sup>3</sup> minimum; STC ratings as indicated on drawings:
  1. Acceptable Products: Use only mineral fibre batts (glass fibre or mineral wool) forming a part of gypsum board manufacturer's tested acoustic assemblies.
5. Steel Drill Screws: To ASTM C1002, unless otherwise indicated, except use screws in accordance with ASTM C954 for fastening panels to steel members from 0.84 mm to 2.67 mm thickness, and as follows:
  1. Type S: Shallow pitch screw; used for single layer gypsum board application.
  2. Type G: Steep pitch screw; used for double layer gypsum board application.
6. Steel Sheet Backing Plates: Steel sheet for blocking and bracing in length and width indicated on Drawings; 1.2 mm nominal core metal thickness x minimum 400 mm wide in accordance with ASTM C645 requirements for metal and with ASTM A653/A653M, Z120, hot dip galvanized zinc coating.
7. Joint Tape: To ASTM C475/C475M, Type as recommended by gypsum board manufacturer for type of installation; use only mould resistant materials for mould and moisture resistant materials.

8. Joint Treatment Materials for Gypsum Board: Provide joint compound and accessory materials in accordance with ASTM C475/C475M; for each coat use formulation that is compatible with other compounds applied on previous or for successive coats, and as follows:
  1. Pre-Filling: Setting type taping compound.
  2. Embedding and First Coat: Drying Type-Compound.
  3. Fill Coat: Drying Type-Compound.
  4. Finish Coat: Drying type, sandable topping compound.
  5. Skim Coat: Drying type, sandable topping compound.
9. Joint Compound for Interior Mould and Moisture Resistant Gypsum Board: Provide joint compound and accessory materials in accordance with ASTM C475/C475M; for each coat use formulation that is compatible with other compounds applied on previous or for successive coats and as follows:
  1. Pre-Filling: Setting type joint compound.
  2. Embedding and First Coat: Setting type joint compound.
  3. Fill Coat: Setting type, sandable topping compound.
  4. Skim Coat: Setting type joint compound, sandable topping compound.

### 3 EXECUTION

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Mould Prevention: Do not install gypsum boards that are wet, that have been damaged by moisture, or that have evidence of mould growth such as fuzzy surfaces or dark splotchy surfaces and discolouration:
  1. Keep gypsum board dry throughout installation.
  2. Do not install gypsum board over other building materials where conditions exist that are favourable to mould growth.
  3. Install gypsum board installed on walls with a minimum 6 mm gap between bottom edge of panel and floor surface.
2. Fire Rated Construction: Install materials forming a part of fire rated construction in accordance with manufacturer's instructions and as required by specific ULC listed construction requirements submitted by Contractor:
  1. Install fire rated gypsum wall panels vertically; horizontal installation does not meet testing standard unless horizontal blocking is installed behind horizontal joints.
  2. Install fire rated sealants after application of acoustic sealing materials, coordinate joint configuration with manufacturers ULC installation requirements.
3. Cold Weather Application of Gypsum Board: Install gypsum board and joint compound in accordance with GA requirements and manufacturer's instructions, and as follows:
  1. Provide temporary heat and moisture control for a period sufficiently in advance of gypsum board and joint compound application to allow building and substrates to acclimate to installation temperature and moisture range required by manufacturer.
  2. Maintain temporary heat until permanent building heating system is started and continuously running.
  3. Provide suitable ventilation to allow materials to dry properly; prevent excessive air movement that could dry materials too quickly and that could cause shrinkage cracking.

### 3.3 INSTALLATION

1. Gypsum Board Application and Finishing Standards: To ASTM C840 and generally at the following locations and as indicated on Drawings:
  1. Fire Resistant Type: Fire resistance rated assemblies; fire resistant description can modify any of the following gypsum board types.
  2. Regular Type: Vertical surfaces not subject to wetting.
  3. Sag Resistant Type: Overhead and horizontal surfaces not subject to wetting.
  4. Mould and Moisture Resistant Type: Vertical and horizontal surfaces subject to wetting.
  5. Acoustic Type: Acoustically rated assemblies.
2. Panel Application Methods: Install in accordance with ASTM C840 and manufacturer's written instructions and as follows:
  1. Single Layer Application:
    1. Partitions: Apply gypsum boards vertically (parallel to framing), unless horizontal application is indicated or otherwise required by fire resistance rated assembly, and to minimize end joints.
    2. Stagger abutting end joints not less than one framing member in alternate courses of board.
    3. Tall Partitions: Apply gypsum boards horizontally, unless otherwise required by fire resistance rated assembly.
    4. Apply gypsum boards using Type S screws fastened 10 mm from edges of board with screws long enough to penetrate 10 mm into metal framing.
3. Install sound attenuation acoustic insulation before installing gypsum boards unless blankets are readily installed after panels have been installed on one side.
4. Install gypsum boards with face side out; butt panels together for a light contact at edges and ends with not more than 1.5 mm of open space between panels; do not force into place.
5. Locate edge and end joints over supports:
  1. Do not place tapered edges against cut edges or ends.
  2. Stagger vertical joints on opposite sides of partitions.
  3. Do not make joints other than control joints at corners of framed openings.
  4. Stop gypsum board away from underside of structure above to allow for deflection of structure.
  5. Attach gypsum board to vertical studs, not to ceiling track, to allow for deflection.
6. Attach gypsum boards to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
7. Attach gypsum boards to framing provided at openings and cut outs.
8. Cover both faces of steel stud partition framing with gypsum boards in concealed spaces (above ceilings, etc.), except in chases braced internally:
  1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 0.7 m<sup>2</sup> in area.
  2. Fit gypsum boards around ducts, pipes, and conduits.
  3. Cut gypsum boards to fit profile formed by coffer, joists, and other structural members where partitions intersect open concrete coffer, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks; allow 6 mm to 10 mm wide joints to install sealant.
9. Isolate perimeter of non-load bearing gypsum board partitions at structural abutments, except floors. Provide 6 mm to 13 mm wide spaces at these locations, and trim edges with J-bead edge trim where edges of gypsum boards are exposed. Seal joints between edges and abutting structural surfaces with acoustic sealant.

10. Space fasteners in gypsum boards according to referenced gypsum board application and finishing standard and manufacturer's written recommendations, and as follows:
  1. Space screws a maximum of 300 mm o/c for vertical applications.
  2. Space fasteners in panels that are tile substrates a maximum of 200 mm o/c.
11. Install fire rated and labelled gypsum board at locations indicated on Drawings; continue fire and smoke rated wall construction behind and around fire hose cabinet recesses and other recessed items larger than a double gang switch box to maintain wall fire rating:
  1. Place self-adhering labels or apply stencilled and painting assembly identification in accordance with Section 07 05 53 – Fire and Smoke Assembly Identification.
12. Install sheet metal wall backing continuously where reinforcement is required for wall hung accessories and assemblies and as follows:
  1. Butt joints between adjoining metal sheets.
  2. Form sheet metal extending 150 mm on each side of wall and ceiling corners without joints where metal backing is continuous around corners.
  3. Spot glue first gypsum board layer at 150 mm o/c to metal backing to hold in place before mechanically fastening surface layer of gypsum board in a two-layer installation.
13. Finishing Gypsum Board Assemblies:
  1. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
  2. Pre-fill open joints rounded or bevelled edges, and damaged surface areas.
  3. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
  4. Gypsum Board Finish Levels: Finish panels to levels indicated above in this Section.
  5. Water Resistant and Mould Resistant Gypsum Board: Do not tape or fill joints in water resistant and mould resistant gypsum board used as a substrate for ceramic tile.
14. STC Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustic sealant. Install acoustic sealant at both faces of partitions at perimeters and through penetrations. In accordance with ASTM C919 and manufacturer's written recommendations for locating edge trim and closing off sound flanking paths around or through gypsum board assemblies, including sealing partitions above acoustic ceilings.
15. Acoustic Sealants: Seal sound rated partitions in strict in accordance with gypsum board manufacturer's instructions for the specific sound rating requirements. Provide two (2) beads of sealant where no sealants are indicated; one under each inner and outer layer of gypsum board.
16. Acoustic Sound Batts: Install acoustic sound batts within metal stud space and above suspended gypsum board ceilings as indicated for sound or fire rating and as follows:
  1. Acoustic sound batts to extend full height of partitions.
  2. Fill behind electrical outlet boxes, fire hose cabinets, washroom accessories and other openings with at least 150 mm lap around perimeter of opening; do not compress acoustic sound batts as this could cause the gypsum board finish to bulge or push outward.
  3. Coordinate with Electrical and Mechanical Subcontractors and verify that no back-to-back openings are formed, whether so indicated on drawings.
  4. Installation to in accordance with manufacturer's current written recommendations.
17. Seal fire rated partitions strictly in accordance with fire sealant manufacturer's instructions for specific fire rating requirements listed; coordinate with Section 07 84 00 – Firestopping.
18. Locate sealant so that it is covered at completion of partition when finishes applied.
19. Seal around mechanical and electrical work and other work in wall to maintain proper fire rating.

20. Movement Control Joints: Form control joints to account for thermal movements, to account for movement where direction of framing changes direction, and movements arising differing substrate materials using V-Shaped trims by framing back-to-back framing members and a break in gypsum board at a maximum of 7.5 metres o/c, as follows:
1. Install control joints in wall and ceiling construction in accordance with ASTM C840 so that gross area enclosed by joints does not exceed 80 m<sup>2</sup> between joints using limiting distances as follows:
    1. Interior Partitions: 9 metres maximum single dimension.
    2. Interior Ceilings with Perimeter Relief: 15 metres maximum single dimension.
    3. Interior Ceilings without Perimeter Relief: 9 metres maximum single dimension.
  2. Lay out control joints to coincide as far as possible with door, window, or screen frames, but not necessarily to occur at every individual frame; install control joints vertically and horizontally from corners of openings.
  3. Provide continuous dust barrier behind joints.
  4. Install joints straight and true.
  5. Form control joints to meet sound rated construction and fire ratings required for remainder of wall or ceiling construction.
  6. Obtain Consultant's acceptance of control joint layout before starting installation of materials specified in this Section.

### 3.4 CLOSEOUT REQUIREMENTS

1. Adjusting and Repairing: Touch-up minor damage to finishes in accordance with manufacturer's instructions; remove and replace gypsum board panels that cannot be successfully cleaned and repaired.
2. Protection: Protect installed products and components from damage during construction.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for the substrate preparation, supply and installation of ceramic and porcelain tile grouts, and tile setting accessories including edge strips, transition strips, control strips, movement joints, and other accessories as required for a complete installation.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American National Standards Institute/Ceramic Tile Institute (ANSI/CTI):
  1. ANSI A108/A118/A136.1:2020, Specifications for the Installation of Ceramic Tile
  2. ANSI A137.1:2021, Standard Specification for Ceramic Tile
3. American Society for Testing Materials (ASTM International):
  1. ASTM C627-18, Standard Test Method for Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester
4. Terrazzo, Tile and Marble Association of Canada (TTMAC):
  1. 2019-2021 Specification Guide 09 30 00 Tile Installation Manual
  2. 2017-2019 Hard Surface Maintenance Guide

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures:
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's product data for each type of product specified. Data shall indicate compliance with specification and installation recommendations of manufacturer of products being used.
  2. Samples for Verification: Submit samples for verification including sample sets showing the full range of variations expected where products involve normal colour and texture variations:
    1. Submit two (2) pieces of each tile specified.
    2. Submit 300 mm x 300 mm sized panel using specified material including coloured grout mounted on 19 mm thick plywood backer.
    3. Full size units of each type of trim and accessory for each colour required.
    4. Metal edge strips in 150 mm lengths.
3. Informational Submittals: Provide the following submittals during the course of the work:
  1. Certificates: Submit written statements from manufacturers indicating compatibility with respect to other manufacturer's materials where more than one manufacturer's products form a part of a single tile assembly.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.5 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of TTMAC Maintenance Guide in accordance with Section 01 78 23 – Operation and Maintenance Data, and additional materials as follows:
  1. Provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.
  2. Provide manufacturer's maintenance data sheets for floor sealers and other non-tile accessories.
2. Maintenance Materials: Deliver maintenance materials to Owner in accordance with Section 01 78 43 – Spare Parts as follows:
  1. Deliver minimum 1 – 4 litre container of cleaning products as specified for maintenance cleaning below and store as directed by Owner.
  2. Deliver tile maintenance materials from the same colour/dye lot in the following quantities:
  3. Ceramic Tile: 2% of total installation with a minimum of 8 pieces of each colour and type
  4. Porcelain Tile: 2% of total installation with a minimum of 1 box of each colour and type.
  5. Trim Units: 3% of total installation consisting of full-size units of each type, composition, colour, and pattern.

## 1.6 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Standard of work for this Section: Provide materials and workmanship in accordance with recommendations of Terrazzo, Tile and Marble Association of Canada (TTMAC) and the material and installation standard contained in the referenced standards.
  2. Supplier: Obtain materials from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties.
  3. Materials: Tile that does not meet a Grade 1 Standard or is marked as a factory second or discount will be rejected, immediately removed from the site, and replaced with specified materials.
  4. Installers: Use qualified personnel, skilled in ceramic and porcelain tile installation, having a minimum of two (2) years of experience and that have completed tile installations similar in material, design, and extent to that indicated for this Project.

## 1.7 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use in accordance with ANSI A108.1 for labelling sealed tile packages.
2. Storage and Handling Requirements: Store materials to prevent damage or contamination to materials by water, freezing, foreign matter, and other causes; store cementitious materials in a dry area, and blocked off floor and ground surfaces.

## 1.8 SITE CONDITIONS

1. Apply tile after completion of work by other Sections is complete; to surfaces sufficiently dry, clean, firm, level, plumb and free from oil or wax or any other material deleterious to tile adhesion, and as follows:
  1. Temperature: Maintain tile materials and substrate temperature between TTMAC recommended minimum and maximum temperature range; unless indicated otherwise by manufacturer, for 48 hours before and during installation until materials are fully set and cured; provide additional heat during winter months or at any other time when there is a risk that surface temperatures may drop below minimum recommended temperatures.



2. Ventilation: Maintain adequate ventilation where Work of this Section generates toxic gases or where there is a risk of raising relative humidity to levels that could damage building finishes and assemblies.

## 2 Products

### 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Performance Requirements: Provide tile products manufactured in accordance with ANSI A108.1 or ANSI A137.1 as appropriate to the Basis-of-Design Products, and as follows:
  1. Colour Variations: Factory blend tile that exhibits colour variations within the ranges selected; package so tile units taken from one package showing same range in colours as those taken from other packages.
  2. Slip Resistance: Provide materials having a minimum Dynamic Coefficient of Friction (DCOF) of 0.45 wet in accordance with ANSI A137.1 when tested using the BOT-3000 Digital Tribometer.
  3. Load Bearing Performance: Provide installations rated for the following load bearing performance in accordance with ASTM C627 for ceramic tile installed on walkway surfaces:
    1. Extra Heavy: Passes cycles 1 through 14.
  4. Floor Level Tolerances: Make slabs flat measured to a minimum of F<sub>F</sub>50, equivalent to ±3 mm with no more than 2 gaps under 3000 mm straightedge; F<sub>F</sub>25 for slabs on grade, and as specified in Section 09 05 61 – Common Work Results for Flooring Preparation.

### 2.3 MATERIALS

1. Wall Tile (WT-1): Ceramic mosaic wall tile, cushioned edge, conforming to referenced standard, and as follows:
  1. Dimensions: Nominal 305 mm x 305 mm x 6 mm thickness.
  2. Pattern: Herringbone.
  3. Colour and Finish: White colour, matte finish.
  4. Basis-of-Design Products: Centura, Mosaic Pan Dan Ecru Matte.
2. Wall Tile (WT-2): Porcelain tile, conforming to referenced standard, and as follows:
  1. Dimensions: Nominal 305mmx 610mm
  2. Colour and Finish: Shell White, matte finish
  3. Pattern: Horizontal Stacked
  4. Basis-of-Design Products: Olympia Tile, Regal Series.
3. Floor Tile (T-1): Porcelain tile, slip resistant, square, conforming to referenced standards, and as follows:
  1. Dimensions: Nominal 305 mm x 305 mm.
  2. Colour and Finish: Grey colour, matte finish.
  3. Basis-of-Design Products: Olympia Tile, Regal Series

4. Floor Tile (T-2), Porcelain Tile, slip resistant, confirming to referenced standards, and as follows:
  1. Dimensions: Nominal 305 mm x 610 mm
  2. Colour and Finish: Grey, Matte Finish
  3. Basis-of-Design Products: Olympia Tile, Regal Series

## 2.4 ACCESSORIES

1. Transition Profiles:
  1. Tile to Resilient Flooring (TR-1): Profile with sloped exposed surface, 4 mm tall leading edge, integrated trapezoid-perforated anchoring leg and integrated grout joint spacer, brushed stainless steel Type 304, and as follows:
    1. Basis-of-Design Product: Schlüter Systems, RENO-U-~~EB~~, Brushed Stainless Steel
  2. Tile to Exterior (TR-6): To be selected by Consultant.
2. Outside wall corner and wall termination strips:
  1. Colour coated aluminum, colour to match tile grout, Jolly-AC.
- 2-3. Tile Backer Boards: Refer to Section 09 28 00 – Backing Boards.
- 3-4. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers and as follows:
  1. Job Site Cleaner: Phosphoric acid/nitric acid-based cleaning solution mixed in accordance with cleaner manufacturers recommendations and as recommended by tile manufacturer.
  2. Maintenance Cleaner: Non-toxic, electrolytic, biodegradable, non-ammonia containing, pH-controlled cleaning solution mixed in accordance with manufacturer's recommendations.

## 2.5 MORTAR SETTING MATERIALS

1. Interior Thin Set Wall System: Dry set mortar meeting or exceeding the requirements of ANSI A108.1 formulated for thin set applications of ceramic biscuit tile, factory sanded mortar consisting of portland cement, sand and additives requiring only potable water to be added for installation complete with ANSI A108.1 bond enhancing latex additive, and as follows:
  1. Basis-of-Design Products: MAPEI Inc., Ultralite S2.
2. Rapid Setting Mortar: Dry set mortar meeting or exceeding the requirements of ASTM C627 for Extra Heavy installation using rapid curing, latex modified, portland cement mortar meeting requirements of ANSI A108.1, and as follows:
  1. Basis-of-Design Products: MAPEI Inc., Ultraflex RS.
3. Large Format Tile Mortar: Medium bed, dry set polymer modified mortar system designed specifically for use with large format tile materials, requiring only the addition of water, rated for extra heavy service installation:
  1. Basis-of-Design Products: MAPEI Inc., Ultraflex LFT.

## 2.6 GROUT

1. Colour will be selected by Consultant from manufacturer's standard range.
2. Epoxy Grout for Floors and Walls: Water cleanable, chemical resistant, factory blended modified portland cement compound with 100% epoxy additives and hardeners meeting requirements of ANSI A108.1, and as follows:
  1. Basis-of-Design Products: MAPEI Inc., Kerapoxy CQ.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine materials ordered for the project before delivering to the site; open boxes and confirm that materials match accepted samples, are free from defects and breakage detrimental to final appearance and installation, and as follows:
  1. Consultant will only accept Grade 1 Standard, materials appearing on site factory marked as seconds or discounted or that are not consistent with materials submitted for review will be rejected.
  2. Replace unacceptable materials at no additional cost to the Owner; order replacement materials using most expedient delivery method to minimize effect on construction schedule.
2. Examine substrates, areas, and conditions where tile will be installed for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile and confirm the following:
  1. Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and are within starting flatness tolerances.
  2. 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.
  3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; adjust joints in consultation with Consultant where joints are not coordinated.
  4. Verify that concrete substrates have been allowed to cure for a minimum of 90 days in accordance with TTMAC requirements.
  5. Verify that tile subject to colour variations has been blended in the factory and packaged so tile units taken from one package show the same range of colours as those taken from other packages. If not, factory blended, blend tiles at site before installing.
  6. Verify that back of tile is free from contamination before installation.
  7. Notify Contractor in writing of any conditions that are not acceptable; do not proceed with installation until unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Surface Preparation:
  1. Prepare floors in accordance with Section 09 05 61 – Common Work Results for Flooring Preparations and as specified in this Section to surface profile required by tile manufacturer.
  2. Make backing surfaces level and true to a tolerance in plane of  $\pm 3$  mm in 2440 mm for walls and  $\pm 3$  mm in 3050 mm for floors using mortar specified in this Section.
  3. Use trowellable levelling and patching compounds in accordance with tile setting material manufacturer's written instructions to fill cracks, holes, and depressions.
  4. Remove protrusions, bumps, and ridges by sanding or grinding.

#### 3.3 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 setting and grouting materials, and to methods required for complete ceramic 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. 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. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints.
  2. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.
4. Lay tile in patterns indicated on Drawings, and as follows:
  1. Align joints when adjoining tiles on floor, base, walls, and trim are the same size.
  2. Lay out tile Work and centre tile sites in both directions in each space or on each wall area.
  3. Centre tile patterns between control and movement joints. Notify the Consultant for further instructions where tile patterns do not align with control or movement joints.
  4. Cut tile accurately and without damage.
  5. Smooth exposed cut edges with abrasive stone, where exposed.
  6. Chipped or split edges are not acceptable.
  7. Minimum tile width: 1/2 unit unless specifically indicated otherwise on Drawings.
  8. Adjust tile layout to minimize tile cutting.
  9. Provide uniform joint widths.
  10. Make joints between tile sheets the same width as joints within tile sheets so joints between sheets are not apparent in finished Work.
11. Cut, drill, and fit tile as required accommodating Work of other trades.
5. Press setting material into the back of tile having raised or textured backs to provide a minimum of 95% coverage:
  1. Set tile in place while bond coat is wet and tacky before it has skinned over.
  2. Notch bond coat in horizontal straight lines and set on freshly set setting material while moving tile back and forth at 90° to the notches.
  3. Fully support corners and edges of tile with setting material.
  4. Set tile with maximum lippage of 1 mm over a 3 mm wide joint.
6. Prevent rapid drying of setting material:
  1. Do not set tile on dry bed.
  2. Sound tile after setting and replace any hollow sounding units to obtain full bond.
7. Provide additional ventilation as required.
8. Clean excess setting materials from surface of tiles before final set.
9. Sound tiles after setting material have cured and replace hollow sounding tile before grouting.
10. Joint Widths: Install tile with the following joint widths:
  1. Wall Tile: 2 mm.
  2. Floor Tile: 2 mm.
  3. Make joints consistent width and alignment within tile area.
  4. Maintain 2/3 of grout joint depth free of setting material.
11. Install prefabricated edge strips and control joints at locations indicated or where exposed edge of floor tile meets different flooring materials and exposed substrates.
12. Protect exposed edges of floor tile with properly sized transition strips, use sloped reducer strips where uneven transitions between 6 mm and 13 mm occur.

### 3.4 MIXING MORTARS AND GROUT

1. Mix mortars and grouts in accordance with referenced standards, and mortar and grout manufacturers' written instructions.
2. Add materials, water, and additives in accurate proportions.

3. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

### 3.5 CONTROL AND MOVEMENT JOINTS

1. Install prefabricated control and movement joints in tile Work in accordance with detail 301MJ from TTMAC Installation Manual to suit installation indicated.
2. Locate expansion, control, contraction, and isolation joints, as indicated in following table, unless specifically indicated otherwise on the Drawings:

Environment	Minimum	Maximum	Joint Width
Interior	4800 mm	6100 mm	6 mm

3. Do not saw-cut joints after installing tiles:
  1. Locate joints in tile surfaces directly above joints in concrete substrates.
  2. Provide floor control joints over structural control joints.
  3. Install prefabricated joint profiles in accordance with manufacturer's written instructions, set with top surface of joint profile slightly below top surface of tile.
  4. Prepare joints and apply sealants in accordance with requirements of Section 07 92 00 – Joint Sealants.
  5. Keep control and movement joints free from setting materials.
4. Form an open joint for sealant in tile Work wherever a change in the backing wall material occurs, at all vertical interior corners, around penetrating pipes, and fixtures, and where tile abuts other materials or fixtures.

### 3.6 GROUT

1. Install grout in accordance with manufacturer's written instructions, the requirements of the Terrazzo, Tile and Marble Association of Canada (TTMAC), and as follows:
  1. Allow proper setting time before application of grout.
  2. Force grout into joints to a smooth, dense finish.
  3. Remove excess grout in accordance with manufacturer's written instructions and polish tile with clean cloths.
2. Install grout for ceramic tile in accordance with ANSI A108.10.
3. Install chemical-resistant epoxy grouts in accordance with ANSI A108.1; clean from tile surfaces as work proceeds in accordance with manufacturer's written instructions using clean water.

### 3.7 CLOSEOUT ACTIVITIES

1. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter using Job Site Cleaner listed in this Section:
  1. Remove epoxy grout residue from tile as soon as possible.
  2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's written instructions, but no sooner than ten (10) days after installation.
  3. Flush surface with clean water before and after cleaning.
2. Protecting: Leave finished installation clean and free of cracked, chipped, broken, unbonded, or other tile deficiencies, and as follows:
  1. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning.
  2. Protect finished areas from traffic until setting materials have sufficiently cured in accordance with TTMAC requirements.
  3. Protect floor areas from traffic after grouting is completed in accordance with manufacturer's written instructions, and as follows:

1. Keep traffic off floors for a minimum of 24 hours after completion of grouting.
2. Provide protective covering until Substantial Performance of the Work.
3. Protect wall tiles and bases from impact, vibration, heavy hammering on adjacent and opposite walls for a minimum of seven (7) days after installation.

### 3.8 INSTALLATION SCHEDULE

1. Install tile on tile backer board to TTMAC detail 305W.
2. Install tile on concrete floor substrates to TTMAC detail 311F.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of acoustical panel ceilings with exposed suspension system.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A641/A641M-19, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
  2. ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  3. ASTM C635/C635M-22, Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
  4. ASTM C636/C636M-19, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
  5. ASTM E580/E580M-24, Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
  6. ASTM E1264-23, Standard Classification for Acoustic Ceiling Products
3. Ceilings and Interior Systems Construction Association (CISCA):
  1. CISCA Ceiling Systems Handbook
  2. CISCA Seismic Construction Handbook
4. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

### **1.4 DEFINITIONS**

1. Delegated Design Professional Engineer: The professional engineer hired or contracted to the fabricator or manufacturer to design specialty elements, produce delegated design submittals and shop drawings to meet the requirements of the Authorities Having Jurisdiction (AHJ); and who is registered in the province of work; and who is not the Consultant.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate layout and installation of acoustic panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire suppression system, and partition assemblies, and as follows:
  1. Schedule and coordinate installation of ceiling to occur subsequent to completion of overhead mechanical and electrical work.
  2. Schedule and coordinate ceiling installation with mechanical and electrical trades building in components into ceiling finish panels.
  3. Schedule and coordinate removal of mechanical and electrical fixtures and accessories with qualified personnel during demolition, dismantling and removal of existing acoustical panel ceilings.

## 1.6 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified.
  2. Shop Drawings: Submit reflected ceiling plans matching Drawings scale indicating ceiling penetrations and ceiling mounted components; include installation details from system manufacturer illustrating site installation requirements, and as required below for delegated design.
  3. Samples for Verification: Submit sample units of each type of ceiling assembly indicated; in sets for each colour, texture, and pattern specified, showing the full range of variations expected in these characteristics, and as follows:
    1. Panel: 150 mm square samples of each acoustic panel type, pattern, and colour.
    2. Suspension System: Set of 300 mm long samples of exposed suspension system members, including mouldings, for each colour and system type required.
3. Informational Submittals: Provide the following submittals during the course of the Work:
  1. Delegated Design: Submit delegated design submittals indicating details for anchorage and bracing for seismic restraint as required by the Ontario Building Code (OBC) in accordance with Section 01 35 73 – Delegated Design Procedures, and as follows:
    1. Engineering Calculations: Submit engineering calculations indicating compliance with anchorage and bracing of seismic bracing and restraint systems for non-loadbearing partitions and ceiling systems; sealed and signed by a professional engineer responsible for the design.
    2. Commitment to General Reviews by Architects and Engineers: Submit concurrently with Engineered Calculations.
    3. Delegated Design Submittals described above are not required for pre-engineered products specified in this Section and are only required for site fabricated systems.
  2. Pre-Engineered Seismic Bracing: Submit manufacturer's written installation instructions including list of required connectors and fasteners to building structure.
  3. Suspended Ceiling Fastener Test Results: Submit test data indicating that fasteners and anchors used to suspend ceiling systems are sized and spaced appropriately based on suspension system manufacturer's requirements.
  4. Design suspended ceiling system for adequate support of electrical fixtures as required by Electrical Safety Authority.
  - 3-5. Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.7 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.
2. Maintenance Materials: Deliver maintenance materials to Owner in quantities indicated and in accordance with Section 01 78 43 – Spare Parts; provide maintenance materials that match installed products; packaged with protective covering for storage, and identified with labels describing contents and building location and as follows:
  1. Ceiling Panels: 5% of total installation with a minimum of 1 package of each panel type.



2. Suspension Tee and Trim Components: 2% of total installation each component type.

## 1.8 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Manufacturer: Obtain materials from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties.
  2. Installer: Use installer having proven experience in completing acoustic panel ceilings similar in material, design, and extent to that indicated for this project and with a record of successful in-service performance for the previous two (2) years.

## 1.9 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver acoustic panels and suspension system components to Project site in original, unopened packages and store in a fully enclosed space, protected against damage from moisture, direct sunlight, surface contamination, and other causes.
2. Storage and Handling Requirements: Permit acoustic panels to reach room temperature and stabilized moisture content before installing; handle acoustic panels to avoid chipping edges or damaging units; replace damaged units as directed by Consultant.

## 1.10 SITE CONDITIONS

1. Ambient Conditions: Install acoustic unit ceilings only when building is enclosed, has sufficient heat, when overhead mechanical and electrical work is complete, and dust and moisture producing activities are complete; maintain uniform temperatures and relative humidity within range recommended by material manufacturer from the time of installation until Substantial Performance for the project; make adjustments to temperature and humidity gradually within tolerances indicated by manufacturer.

## 1.11 WARRANTY

1. Warranty: Provide manufacturer's standard two (2) years warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

## 2 Products

### 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Acoustic Panels:
    1. Saint-Gobain CertainTeed.
    2. CGC Interiors, A USG Company.
    3. Rockfon North America.
  2. Suspension Systems:
    1. Saint-Gobain CertainTeed.

2. CGC Interiors, A USG Company.
  3. Rockfon North America.
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Suspended Ceiling Fasteners: Provide fasteners having a minimum capacity of 890 N in tension for vertical loading conditions, a minimum capacity of 1960 N in tension and angular and bracing conditions, and as follows:
  1. Steel Roof Decking Anchors: Attachment of suspended ceiling systems directly to steel roof decking is not permitted.
  2. Fasteners and Anchors: Provide attachment devices having five (5) times design load indicated in ASTM C635/C635M, Table 1, Direct Hung, having corrosion protection for severe service conditions, with holes or loops for attaching hangers having capacity to sustain ceiling loads as indicated in above, selected from one of the following types:
    1. Cast-in-place anchors.
    2. Post Installed expansion anchors.
    3. Chemical anchors.
2. Seismic Response Characteristics: Design anchorages, bracing, restraints and other structural components of non-structural assemblies and components in accordance with the OBC, and as follows:
  1. Importance Characteristics: Provide fastenings, seismic bracing, and restraints to withstand seismic forces outlined in the OBC for Post-Disaster Importance Category.
3. Superimposed Loads: Determine superimposed loads applied to suspension systems by components of the building and verify that adequate hangers are installed to support additional loads in conjunction with normal loads of the ceiling system, and as follows:
  1. Maximum Deflection: Limit deflection to L/360 in accordance with ASTM C636/C636M deflection test.

## 2.3 MATERIALS

1. Acoustic Panel Ceilings (ACT): Provide manufacturer's standard panels of configuration indicated in accordance with ASTM E1264 classifications as designated by the nominal values for types, patterns, acoustic ratings, and light reflectance class listed in this Section; with flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with CAN/ULC S102, and as follows:
  1. Physical Properties: Type B, Form B2.
  2. Pattern: E.
  3. Fire Class: A.
  4. Dimensions:
    1. ACT-1: Nominal 610 x 610 mm x 25 mm.
    2. ACT-2: Nominal 1220 x 1220 mm x 25 mm.
  5. Edge Profile: Tegral.
  6. Colour: White.
  7. Acoustic and Visual Performance:
    1. NRC: 0.95.
    2. LR: 0.88.
  8. Basis-of-Design Products: Armstrong, OPTIMA.

2. Metal Suspension System – Acoustical Panel Ceilings: Manufacturer's standard direct hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C635/C635M and ASTM C636/C636M requirements and as supplied by same materials supplier as acoustic panels for intermediate duty, exposed tee bar, and as follows:
  1. Tee Bar Grid Face Width: As appropriate for materials specified.
  2. Module: Sized as appropriate to acoustic panel size.
  3. Hangers, Braces and Ties: Nominal 12 ga. steel wire, galvanized in accordance with ASTM A641/A641M.
  4. Exposed Finish: Manufacturer's standard satin, white finish.
  5. Corrosion Resistance: Hot-dip galvanized or stainless steel components.
  6. Basis-of-Design Products: Armstrong, Prelude 15/16" – Blizzard White.
3. Attachment Devices: Provide anchors and fasteners sized and spaced in accordance with performance requirements indicated above and as required by manufacturer of ceiling suspension components and as follows:
  1. Rod and Flat Hangers: Mild steel, zinc coated.
  2. Angle Hangers: Minimum 22 mm x 22 mm x 1 mm thick angles, Z275 (G90) galvanized steel sheet in accordance with ASTM A653/A653M; bolted connections using 8 mm Ø bolts.
4. Edge Mouldings and Trim: Sheet metal edge mouldings and trim selected from manufacturer's standard mouldings for edges and penetrations that fit specified acoustic panel ceiling edge and suspension system.

## 2.4 ACCESSORIES

1. System Accessories:
  1. Hold-Down Clips for Wind Uplift: Provide hold down clips spaced 610 mm O/C on all cross tees for interior ceilings consisting of acoustic panels weighing less than 4.88 kg/m<sup>2</sup>.
  2. Impact Clips: Where indicated, provide manufacturer's standard impact clip system designed to absorb impact forces against acoustic panels.
  3. Sealant: Acrylic type as specified in Section 07 92 00 – Joint Sealants for use in exposed locations, colour to match ceiling grid.
  4. Pre-manufactured Control Joints: Manufacturer's recommended movement and expansion control joints for use in exposed locations where required.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

1. Modify existing ceiling grid and install new wall moulding to suit partition layout as indicated on Drawings.
2. Provide cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.
3. Measure each ceiling area and establish layout of acoustic panels to balance border widths at opposite edges of each ceiling:
  1. Install acoustic panel ceilings in accordance with layout indicated on reflected ceiling plans.
  2. Layout acoustic panel ceilings to avoid use of panels less than half the width of full-sized panels at borders.

### 3.3 INSTALLATION

1. Manufacturer's Instructions: Install acoustic panel ceilings in accordance with manufacturers written instructions, and as follows:
  1. Install ceiling suspension system in accordance with ASTM C636/C636M.
  2. Install ceiling suspension systems requiring seismic restraint in accordance with ASTM E580/E580M.
2. Acoustic Panel Suspension System: Install acoustic panel system by suspending ceiling hangers from building's structural members, and as follows:
  1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system:
    1. Do not support ceilings directly from permanent metal forms, steel floor decking or other non-structural framing; fasten hangers to cast-in-place hanger inserts, powder actuated fasteners, or drilled in anchors that extend through forms and steel floor decking into concrete.
    2. Do not attach hangers to steel deck tabs; do not attach hangers to steel roof decking; attach hangers to structural members or intermediate supports.
    3. Provide additional carrier channels between structural elements where structure does not align with hangers.
    4. Do not connect or suspend steel framing from ducts, pipes, or conduit.
  2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other means that does not create a kink in the suspension wires.
  3. Install supplemental suspension members and hangers in form of trapezes or similar devices 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.
  4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns.
  5. Connect hangers directly to structure or to flat, angle, channel or rods securely fastened to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are:
    1. Secure.
    2. Appropriate for substrate.
    3. Will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  6. Space hangers at 1220 mm maximum along each member supported directly from hangers and provide hangers not more than 200 mm from ends of each member.
  7. Provide additional hangers where lay-in electrical or mechanical fixtures are installed in suspension system; one at each corner with stabilizer bars to prevent overloading or rotation of the suspension members where required.
  8. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
  9. Do not level ceilings by putting kinks in the suspension wires.
3. Trims and Edging: Install edge mouldings and trim of type indicated at perimeter of acoustic ceiling area and where necessary to conceal edges of acoustic panels.

4. Acoustic Panels: Accurately fit and install acoustic panels into suspension system runners and edge mouldings; scribe and cut panels at borders and penetrations to provide a neat, precise fit; replace damaged panels at no expense to the Owner, and as follows:
  1. Arrange directionally patterned acoustic panels as follows:
    1. As indicated on reflected ceiling Drawings.
  2. Square Edged Panels: Install panels with edges fully hidden from view by flanges of suspension system runners and mouldings; use sheet metal filler coloured to match suspension system where any face dimension of a piece of acoustic panel, measured from centre of Tee to face of wall or column is less than 75 mm.
  3. Install hold down clips in areas required by Authorities Having Jurisdiction (AHJ), spaced as recommended by acoustical panel ceiling manufacturer's written instructions.

### 3.4 CLOSEOUT REQUIREMENTS

1. Repairing: Touch-up minor damage to finishes in accordance with manufacturer's instructions; remove and replace ceiling components that cannot be successfully cleaned and repaired.
2. Cleaning: Clean exposed surfaces of acoustic panel ceilings, including trim, edge mouldings, and suspension system members in accordance with manufacturer's instructions.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies the requirements for the supply and installation of resilient flooring and accessories including, but not limited to, the following:
  1. Resilient Tile Materials:
    1. Luxury vinyl tile.
  2. Resilient Sheet Materials:
    1. Static dissipative vinyl flooring.
  3. Resilient Accessories:
    1. Resilient wall base.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Association of Textile Chemists and Colorists (AATCC):
  1. AATCC 134-2019, Test Method for Electrostatic Propensity of Carpets
3. American Society for Testing and Materials (ASTM International):
  1. ASTM F150-06(2018), Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
  2. ASTM F1066-23, Standard Specification for Vinyl Composition Floor Tile
  3. ASTM F1344-21a, Standard Specification for Rubber Floor Tile
  4. ASTM F1861-21, Standard Specification for Resilient Wall Base
  5. ASTM F2170-19a, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in Situ Probes
4. National Fire Protection Association (NFPA):
  1. NFPA 255-2006, Standard Method of Test of Surface Burning Characteristics of Building Materials
5. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102.2:2018, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Close spaces to traffic during flooring installation and until time period after installation recommended in writing by manufacturer; install flooring and accessories after other finishing operations, including painting and ceiling construction have been completed.

### **1.5 SUBMITTALS**

1. Submit requested materials in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified.
  2. Samples for Verification: Submit samples for verification of each different specified product for verification of colour and pattern in manufacturer's standard sample size.

3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit manufacturer's written instructions for maintenance and cleaning procedures, include list of manufacturers recommended cleaning and maintenance products, and name of original installer and contact information in accordance with Section 01 78 23 – Operation and Maintenance Data.
2. Maintenance Materials: Provide extra materials that match installed products; packaged with protective covering for storage, and identified with labels describing contents in accordance with requirements of Section 01 78 43 – Spare Parts as follows:
  1. Tile Materials: 2% of total installation with a minimum of one (1) box of each colour and type.
  2. Resilient Base and Accessories: 5% of total installation with a minimum of 2400 mm length of each colour and type.

#### **1.7 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Source Limitations: Obtain each type, colour, and pattern of flooring or accessories specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
2. Certifications: Provide proof of the following during the course of the Work:
  1. Compatibility Certificate: Provide letter from floorcoverings adhesive manufacturers stating that Products proposed for use on the Project are compatible with floorcoverings substrates, floorcoverings preparation and floorcovering specified throughout Division 09 – Finishes.

#### **1.8 DELIVERY, STORAGE, AND HANDLING**

1. Delivery and Acceptance: Deliver flooring and installation accessories to site in manufacturer's original, unopened cartons and containers, bearing names of product and manufacturer, project identification, and shipping and handling instructions.
2. Storage and Handling: Store products in dry spaces protected from the weather, with ambient conditions maintained between manufacturer's recommended temperature range, and as follows:
  1. Do not stack tile goods over four cartons high and distribute cartons evenly over floor area to prevent overloading of structure.
  2. Keep water-based adhesives from freezing.
  3. Store rolls upright in accordance with manufacturer's instructions.

#### **1.9 SITE CONDITIONS**

1. Ambient Conditions Maintain temperature and ventilation in work area using permanent heating system, and portable supply and exhaust fans in accordance with manufacturer's requirements, and as follows:
  1. Move products and accessories into spaces where they will be installed a minimum of 72 hours before installation.
  2. Maintain a minimum temperature of 18°C after installation to prevent damage to resilient materials.
  3. Do not install products and accessories on substrates colder than ambient air temperature.
  4. Install products and accessories when they are at the same temperature as the space where they are installed.

### 1.10 WARRANTY

1. Manufacturer's Warranty: Provide manufacturer's standard one (1) year warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

## 2 Products

### 2.1 MATERIALS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Regulatory Requirements: Provide products that meet requirements of CAN/ULC S102.2 as applicable for required flame spread ratings; labelled and listed by Underwriters Laboratories of Canada (ULC), or another testing and inspecting agency acceptable to Authority Having Jurisdiction.
2. Provide static dissipative resilient flooring as a complete system having accessories, adhesive, copper grounding strips and maintenance finish supplied by one manufacturer and providing the following static performance requirements:
  1. Dissipative Flooring:
    1. Resistivity Range: of  $1 \times 10^6$  to  $1 \times 10^9 \Omega$  tested in accordance with ESD STM7.
    2. Static Generation: Less than 100 volts when tested in accordance with AATCC-134.
    3. Static decay of 5000 volts to 0 in less than 0.2 seconds in accordance with Federal Test Method 4046-101C.

### 2.3 MATERIALS

1. Luxury Vinyl Tile (LVT-1):
  1. Colour: Genuine Oak.
  2. Thickness: 3.0 mm overall thickness.
  3. Size: Nominal 150 mm x 1220 mm.
  4. Basis-of-Design Products: Tarkett North America, Event+ Series Luxury.
2. Solid Vinyl Tile – Static Dissipative (SD-1):
  1. Colour: Moonstone.
  2. Thickness: 2.0 mm overall thickness.
  3. Size: 615 mm x 615 mm.
  4. Static Dissipation Range: Having a resistance of  $1 \times 10^6 \leq R \leq 10^8 \Omega$  in accordance with IEC 61340-4-1 and ESD STM7.1.
  5. Basis-of-Design Products: Forbo Flooring Systems, Colorex SD.

### 2.4 ACCESSORIES

1. Transition Profiles:
  1. Resilient Flooring to Sealed Concrete (TR-3): Transition profile with sloped exposed surface and integrated perforated tapered anchoring leg, brushed chrome anodized aluminum finish, and as follows:
    1. Basis-of-Design Products: Schlüter Systems, VINPRO-U, Brushed Chrome Anodized.



2. Resilient Flooring to Exterior (TR-4): To be selected by Consultant.
3. Resilient Flooring to Static Resilient Flooring (TR-5): T-Shaped brushed chrome anodized aluminum profile with 14 mm wide visible surface, 1 mm thick beveled exposed surface and 3 mm anchoring leg, and as follows:
  1. Basis-of-Design Products: Schlüter Systems, VINPRO-T, Brushed Chrome Anodized.
2. Resilient Wall Base (RB-1): To ASTM F1861, and as follows:
  1. Type and Group: Type TP, Group 1.
  2. Colour:
    1. At Resilient Flooring and Sealed Concrete: 63 Bedrock.
    2. At Tile: To match tile base TB-1 and TB-2.
    3. At Tile Carpeting: To match RB-1 at all carpet areas.
  3. Height: 102 mm.
  4. Thickness: Nominal 3.2 mm.
  5. Length: Manufacturer's standard maximum length.
  6. Basis-of-Design Products: Tarkett, Type TS, Thermoset Rubber, BaseWork 4", 63 Bedrock (toeless).
3. Trowellable Levelling and Patching Compounds: Latex modified, portland cement-based formulation provided or approved by resilient product manufacturer for applications indicated; Gypsum based materials will not be accepted for use on this project.
4. Adhesives: Solvent free, water-resistant primer and adhesive as recommended by flooring or resilient accessory manufacturer to suit resilient products specified and substrate materials and conditions, and as follows:
  1. Rubber Base Adhesive: Contact adhesive recommended by resilient base manufacturer.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine substrates, areas, and conditions affecting work are in accordance with manufacturer's requirements.

#### 3.2 PREPARATION

1. Comply with product manufacturer's written installation instructions for preparing substrates indicated to receive resilient products specified.
2. Prepare floors in accordance with Section 09 05 61 – Common Work Results for Flooring Preparation to surface profile required by flooring manufacture.
3. Broom and vacuum clean substrates immediately before installing products specified.
4. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.

#### 3.3 INSTALLATION

1. Comply with resilient manufacturer's written installation instructions.
2. Unroll flooring and allow stabilizing before cutting and fitting in accordance with manufacturer's installation instructions.
3. Layout tile flooring as follows:
  1. Lay tile with joints [parallel] to building lines or as indicated on drawings to produce a symmetrical tile pattern.
  2. Install tile flooring so that perimeter tile width is minimum ½ full size.
4. Static Dissipative Installation System:

1. Adhesive: Static dissipative, water-based resin as recommended by flooring manufacturer to obtain required performance requirements.
2. Grounding Strips: 50 mm wide x maximum length copper ground connection strips as recommended by flooring manufacturer to obtain required performance requirements.
5. Layout resilient base as follows:
  1. Fit joints tight and vertical.
  2. Joints along one plane shall be at minimum 7000 mm spacing, at inconspicuous locations.
  3. Mitre internal corners, groove, and shape back side of base to fit around external corners and exposed ends.
  4. Install resilient wall base on solid backing. Adhere tightly to wall surfaces.
  5. Scribe and fit to door frames and other obstructions.
  6. Install outside corners prior to installation of straight sections.
  7. Install straight and level to variation of plus or minus 3 mm over 3000 mm straight edge.
  8. Do not stretch base during installation.
  9. Shave back of base where necessary to produce snug fit to substrate.

### 3.4 CLOSEOUT REQUIREMENTS

1. Cleaning:
  1. Remove adhesive and other surface blemishes using cleaner recommended by flooring manufacturer.
  2. Sweep or vacuum work surfaces thoroughly.
  3. Do not wash flooring until after time period recommended by flooring manufacturer.
  4. Damp mop floor to remove marks and soil.
  5. Clean flooring in accordance with manufacturers written recommendations.
  6. Clean and strip protective floor finish applied after completing installation only if required to restore polish finish and if recommended by flooring manufacturer.
  7. Reapply polish to floor surfaces to restore protective floor finish in accordance with flooring manufacturer's written recommendations.
  8. Coordinate with Owner's maintenance program and provide listing of materials required to maintain resilient flooring.
2. Protection:
  1. Protect flooring against mars, marks, indentations, and other damage arising from construction operations and placement of equipment and fixtures during the remainder of construction period using protection methods recommended in writing by flooring manufacturer, and as follows:
    1. Apply protective floor finish or sealer, as appropriate to the specified materials, coordinate selection of floor polish or sealer with Owner's long term maintenance service.
    2. Use only commercially available product acceptable to flooring manufacturer and provide list of products used as a part of maintenance instructions specified for this Section.
    3. Confirm with manufacturer that Owners preferred floor polish or sealer is compatible with manufacturers recommended commercial flooring installation maintenance procedures; notify Consultant where Owner's preferred products are not compatible with manufacturers recommendations.
  2. Protect resilient wall base from scratches, gouges, scuff marks and other damage from time initial surface protection application, until final inspection.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of resinous flooring systems including surface preparation and required accessories for a complete installation.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM C579-23, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
  2. ASTM D16-24, Standard Terminology for Paint, Related Coatings, Materials, and Applications
3. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102.2:2018, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Close spaces to traffic during flooring installation and until time period after installation recommended in writing by manufacturer; install flooring and accessories after other finishing operations, including painting and ceiling construction have been completed.

### **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including technical data sheets, application and installation instructions, and maintenance instructions with manufacturer's recommended maintenance practices.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

### **1.7 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Installer Qualifications: Use experienced installers who are qualified or authorized by resinous flooring manufacturer to apply resinous flooring systems specified in this Section.
2. Source Limitations:
  1. Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer.

2. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

### 1.8 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
2. Storage and Handling Requirements: Store and handle materials in accordance with manufacturer's written instructions.

### 1.9 SITE CONDITIONS

1. Ambient Conditions: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.

## 2 Products

### 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Provide primers, undercoats, and finish coat materials that are compatible with one another, and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and site experience.

### 2.3 MATERIALS

1. Mechanical and Electrical Rooms with Cove Base: Liquid applied, 2-component 2-coat, solvent free polyurethane epoxy coating system specifically designed for mechanical equipment room floors, providing waterproof, elastomeric, traffic bearing coating system consisting of primer and wear course approximately 1 mm total DFT; applied on adjacent vertical surfaces to create 150 mm high integral cove base, and as follows:
  1. Colour: Selected by Consultant from manufacturer's standard colour range.
  2. Areas of Application: Room 114 – Mech. and Room 115 – Elec / UPS.
  3. Primer: MAPEI Inc., Prime SN.
  4. Topcoat: MAPEI Inc., Mapefloor I302 SL. System 32 – Non-slip.
2. Traffic Coatings: Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for pedestrian traffic condition minimum 32 mils, and as follows:
  1. Colour: Selected by Consultant from manufacturer's standard colour range.
  2. Areas of Application: Room 118 – Patio.
  3. Primer: MAPEI Inc., Prime SN.
  4. Primer: MAPEI Inc., Mapefloor PU Primer.
  5. Basecoat: MAPEI Inc., Mapefloor PU 400 FC.
  6. Topcoat: MAPEI Inc., Mapefloor 415 NA / 450.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Protection of In-Place Conditions: Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Consultant, and leave in an undamaged condition.
2. Remove plates, machined surfaces, and similar items already in place that are not being coated. If removal is impractical or impossible because of size or weight of item, provide surface applied protection before surface preparation and coating.
3. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
4. Clean substrates of substances that could impair bond of coatings before applying high performance coatings; remove oil and grease before cleaning.
5. Schedule cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.
6. Clean, prepare, and profile surfaces being coated in accordance with manufacturer's written instructions for each substrate condition, and as follows:
  1. Provide barrier coats over incompatible primers or remove primers and re-prime substrate.
  2. Prepare concrete being coated; remove efflorescence, chalk, dust, dirt, grease, oils, and release agents; roughen as required to remove glaze; use mechanical methods to prepare surfaces if hardeners or sealers have been used to improve curing, and as follows:
    1. Use abrasive blast cleaning methods if recommended by coating manufacturer.
7. Carefully mix and prepare coating materials in accordance with manufacturer's written instructions, and as follows:
  1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
  2. Stir materials before applying to produce a mixture of uniform density; stir as required during application; do not stir surface film into the material; remove film and strain coating material before using.
  3. Use only the type of thinners approved by manufacturer and only within recommended limits.

#### 3.3 INSTALLATION

1. Protection during Installation: Provide Wet Paint signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
2. Apply resinous flooring and wall systems in accordance with manufacturer's written instructions, and as follows:
  1. Use applicators and techniques best suited for the material being applied.
  2. Do not apply high performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
  3. Coating colours, surface treatments, and finishes are indicated in the coating system descriptions.
  4. Provide finish coats compatible with primers used.

5. The term 'exposed surface' includes areas visible when permanent or built in fixtures, convector covers, grilles, covers for finned tube radiation, and similar components are in place; extend coatings in these areas to maintain system integrity and provide desired protection, and as follows:
  1. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces; coat surfaces behind permanently fixed equipment or furniture with prime coat only before final installation.
3. Apply first coat to surfaces that have been cleaned, pre-treated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration, and as follows:
  1. The number of coats and film thickness required is the same regardless of application method:
    1. Do not apply successive coats until previous coat has cured in accordance with manufacturer's written installation instructions.
  2. Apply additional coats until cured film has a uniform coating finish, colour, and appearance if undercoats or other conditions show through final coat; give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.
4. Apply base and top coatings in accordance with manufacturer's written installation instructions.
5. Apply each material no thinner than manufacturer recommended spreading rate; provide total dry film thickness of the entire system in accordance with manufacturer's written installation instructions.
6. Apply prime coat to material being coated or finished that has not been prime coated by others in accordance with manufacturer's written installation instructions, before applying finish coats:
  1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn through or other defects caused by insufficient sealing.
7. Remove, refinish, or recoat work that does not are in accordance with specified requirements.

### 3.4 CLOSEOUT REQUIREMENTS

1. Protection:
  1. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Consultant, and leave in an undamaged condition.
  2. Provide Wet Paint signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
  3. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of tile carpeting materials.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Association of Textile Chemists and Colorists (AATCC):
  1. AATCC 16.1-2023, Test Method for Colorfastness to Light: Outdoor
  2. AATCC 134-2019, Test Method for Electrostatic Propensity of Carpets
  3. AATCC 165-2021, Test Method for Colorfastness to Crocking: Textile Floor Coverings—Crockmeter
3. American Society for Testing and Materials (ASTM International):
  1. ASTM D1335-21, Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
  2. ASTM D2859-16(2021), Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
  3. ASTM E662-21ae1, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
4. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102.2:2018, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination:
  1. Coordinate floor flatness and levelling requirements of this section with requirements of Section 09 05 61 – Common Work Results for Flooring Preparation; work of this Section includes floor levelling and patching required to meet resilient flooring manufacturer's installation requirements; notify Consultant where differences occur between specified tolerances and actual conditions.
  2. Install carpeting before installing items indicated for installation on top of carpet and after other finishing operations, including painting and ceiling construction, has been completed.

### **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's standard product data indicating requirements for installation.
  2. Samples for Verification: Submit samples for verification of each type of tile carpeting and adhesive required for the project for confirmation of project requirements.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.
2. Maintenance Materials: Provide extra materials that match installed products; packaged with protective covering for storage, and identified with labels describing contents in accordance with requirements of Section 01 78 43 – Spare Parts as follows:
  1. Tile Carpeting Materials: 2% of total installation with a minimum of 1 box of each colour and type.
  2. Tile Carpeting Accessories: 5% of total installation with a minimum length of 3000 mm of each colour and type,

## **1.7 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Installers: Use installers experienced in the type of work indicated and materials specified and who can demonstrate compliance with certification programs of listed manufacturers for inclusion under warranty conditions listed below in this Section.

## **1.8 DELIVERY, STORAGE AND HANDLING**

1. Delivery and Acceptance Requirements:
  1. Deliver tile carpeting material in original mill protective wrapping with mill register numbers and tags attached.
  2. Deliver other materials in manufacturers unopened containers identified with name, brand, type, grade, class, and other qualifying information.
2. Storage and Handling Requirements: Store materials in a dry location and as recommended by tile carpeting manufacturer.

## **1.9 SITE CONDITIONS**

1. Ambient Conditions: Maintain temperature and ventilation in work area using permanent heating system, and portable supply and exhaust fans in accordance with manufacturer's requirements, and as follows:
  1. Provide 72 hours notification to the Owner before starting installation in occupied spaces.
  2. Install Tile Carpeting when wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for project when occupied for its intended use.
  3. Install Tile Carpeting over concrete subfloor once slabs have cured and are sufficiently dry to bond with adhesive and concrete subfloor have pH range recommended by carpet manufacturer.

## **1.10 WARRANTY**

1. Warranty: Provide manufacturer's standard one (1) year warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

# **2 Products**

## **2.1 MANUFACTURERS**

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.



2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Regulatory Requirements: Use only carpeting materials that have been tested and accepted for labelling under CAN/ULC S102.2 and meeting requirements of the Authority Having Jurisdiction.
2. Floor Level Tolerances: Make slabs flat measured to a minimum of F<sub>F</sub>50 equivalent to  $\pm 3$  mm with no more than 2 gaps under 3000 mm straightedge using floor preparation materials specified in Section 09 05 61 – Common Work Results for Flooring Preparation.
3. Modular tile carpeting performance requirements are based on acceptable minimums published by the Carpet and Rug Institute as follows, and as otherwise modified by actual materials specified:
  1. Dimensional Stability:  $\pm 0.15\%$  Maximum
  2. Tuft Bind: 3.6 kg for Loop Pile, minimum average value based on ASTM D1335.
  3. Colourfastness: Test all specified colours; provide proof of performance before installation of specified materials:
    1. Crocking AATCC 165: Class 4 Minimum, wet and dry.
    2. Lightfastness AATCC 16: Grade 4 Minimum.
  4. Electrostatic Propensity AATCC 134: Permanent static control using static conducting fibres or durable static control for lifetime of carpet where static conducting fibres do not form a part of the manufacturer's standard construction providing  $\leq 3.5$  kV dissipation.
  5. Flammability: Tested in accordance with ASTM D2859 and ASTM E662, and as follows:
    1. Radiant Panel Test: Class 1, 0.45 W/cm<sup>2</sup>.
    2. Smoke Density:  $\leq 450$  Corrected Optical Density.

## 2.3 MATERIALS

1. Tile Carpeting: Tufted texture loop, 100% recycled content nylon, and 100% solution dyed, meeting performance requirements specified in this Section, and as follows:
  1. Traffic Classification: Severe.
  2. Dimensions: 610 mm x 610 mm.
  3. Basis-of-Design Products:
    1. Tile Carpeting (CPT-1) – Static Dissipative Carpet: Static Worx / Interface Inc., Cubic, Shape 004287.
    2. Tile Carpeting (CPT-2): Interface Inc., Primary Stitch, Serpentine/Accent 102423.

## 2.4 ACCESSORIES

1. Transition Profiles:
  1. Tile Carpeting to Resilient Flooring (TR-2): J-Shaped profile with 6 mm wide visible surface and integrated perforated tapered anchoring leg for transition from tile carpeting to resilient flooring, brushed chrome anodized aluminum, and as follows:
    1. Basis-of-Design Products: Schlüter Systems, VINPRO-S Brushed Chrome Anodized.
  2. Tile Carpeting to Tile Carpeting (TR-7): For use over raised floor and concrete slab, and as follows:
    1. Colour: Satin Anodized Finish.
    2. Basis-of-Design Products: Schluter RENO-T, Aluminum. Satin Anodized Finish. 17/32" wide.

2. Adhesive and Seam Cement: Self release type, recommended by tile carpeting manufacturer; low odour based, low Volatile Organic Compound (VOC), and meeting LEED® requirements.
3. Trowellable Levelling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by the Tile Carpeting manufacturer.
4. Seaming Cement: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
5. Resilient Accessories: Transition strips and rubber base as specified in Section 09 65 00 – Resilient Flooring and Accessories, of types indicated on drawings and as required to protect exposed edge of carpet; maximum lengths to minimize running joints.

### 3 Execution

#### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

1. Prepare floors in accordance with Section 09 05 61 – Common Work Results for Flooring Preparation to surface profile required by tile carpeting manufacturer.
2. Subfloor Treatment: Remove dust, dirt, sealer, and wax from existing surfaces; remove ridges and bumps; seal porous and powdery surfaces with concrete floor sealer and apply sub-floor filler to low spots and cracks to achieve level floor to a tolerance of 1:500 in accordance with manufacturer's written requirements.
3. Test Layout: Dry lay 10 m<sup>2</sup> area of tile carpeting with required seam and nap direction and obtain acceptance from Consultant before commencing with installation.

#### 3.3 INSTALLATION

1. Install tile carpeting in accordance with manufacturer's printed instructions using material from same dye lot; mix materials to obtain consistent colour, pattern, and texture match within any one visual area.
2. Layout tile carpeting as with joints parallel to building lines or as indicated on Drawings to produce a symmetrical tile pattern so that perimeter tile width is minimum ½ full size and as follows:
  1. Cut tile carpeting to fit accurately around perimeter of rooms into all recesses and around fixtures.
  2. Make cut outs for floor mounted service boxes, receptacles, switches, hardware where they occur on tile carpeting.
  3. Cut holes as close as possible to allow services to pass through and that trim will completely hide hole when installed.
  4. Cooperate and coordinate with electrical trade to ensure correct location of outlets is obtained.
3. Install edging strips at all openings or doorways and where tile carpeting abuts other floor covering.

#### 3.4 CLOSEOUT REQUIREMENTS

1. Repairing: Replace damaged or defective tile carpeting at no additional cost to the Owner.
2. Cleaning: Remove tile carpeting waste and debris from project site and leave installation area clear after installation and carpeting operations.

3. Protection: Protect installed tile carpeting from damage in accordance with manufacturer's written protection instructions and recommendations.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of access flooring system consisting of a series of modular, removable, interchangeable panels on an elevated support system.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. Ceilings and Interior Systems Construction Association (CISCA):
  1. Recommended Test Procedures for Access Floors, 2007 Edition
2. Underwriters Laboratories Canada (ULC):
  1. CAN/ULC S102:2019 (R2024), Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
  2. CAN/ULC S102.2:18 (R2024), Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
  3. CAN/ULC S135-04 AMD1 R16, Standard Test Method for the Determination of Combustibility Parameters of Building Materials Using an Oxygen Consumption Calorimeter (Cone Calorimeter)

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Pre-Construction Meetings: Conduct pre-construction meeting to verify project requirements and any unique conditions affecting installation, manufacturer's installation instructions and manufacturer's warranty requirements attended by Contractor, Subcontractor, and other Subcontractor's affected by work of this Section, access flooring manufacturer's representative and Consultant in accordance with Section 01 31 19 – Project Meetings.
2. Coordination: Coordinate with adjacent work and verify that concrete floors are acceptable for installation of specified materials; coordinate location of under floor mechanical and electrical work and as follows:
  1. Mark pedestal locations on subfloor by use of a grid based on actual pedestal modules to enable mechanical and electrical work to proceed without interfering with access flooring pedestals.
  2. Proceed with installation only after completion of other work within affected areas.
3. Scheduling: Order materials and provide site verified dimensions for preparation of shop drawings in sufficient time to allow for manufacturer's fabrication lead time and project installation requirements.

### **1.5 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit manufacturer's printed product literature and installation instructions, specifications and data sheet indicating specific materials used for work of this Section.
  2. Shop Drawings: Submit measured shop drawings indicating layout of the work including starting point of installation and details of component panels and pedestals using verified site dimensional relationships to adjoining work and installation tolerances; sizes and details of components; anchorage methods; edge and fascia details; elevations differences; gasketing, floor finishes, and location of connection to building grounding electrode.

3. Informational Submittals: Provide the following submittals when requested by the Consultant:
  1. Certificates: Submit product certificates signed by manufacturer certifying that materials supplied for the project comply with specified performance characteristics, design criteria and physical requirements.
  2. Delegated Design Submittals: Submit data on earthquake resistance in the form of structural computations signed and sealed by a qualified professional engineering including, but not limited to, structural computations, material properties and other information indicating that access flooring system will withstand earthquake loads indicated.
  3. Source Quality Control Submittals: Submit test reports; certified by an independent testing laboratory having a minimum of five years' experience testing access floor components in accordance CISCA Recommended Test Procedures, certifying that component parts perform as specified by the manufacturer.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.6 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit manufacturer's written instructions for repair and cleaning procedures; include name of original installer and contact information in accordance with Section 01 78 23 – Operation and Maintenance Data.
2. Spare Parts and Tools: Submit unique parts and tools in accordance with Section 01 78 43 – Spare Parts, and as follows:
  1. Spare Parts:
    1. Provide two (2) pallets of spare floor panels without floor covering nine (9) spare pedestals, associated stringers and accessory components for maintenance use.
    2. Store spare parts where directed by Owner.
    3. Package spare parts with protective covering and identified with labels describing contents.
  2. Tools:
    1. Provide four (4) floor panel lifting devices and wall mounting bracket for lifting device standard with access floor manufacturer.
    2. Hang floor panel lifting device mounting bracket in location directed by Owner; set lifting device into bracket.

#### 1.7 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Manufacturer: Obtain access flooring from a single source and from a single manufacturer, with panels clearly and permanently marked on underside with panel type and concentrated load rating, tested in accordance with CISCA standards for access flooring.
  2. Zinc Whiskers Protection: Provide steel components coated with electrostatic, baked on corrosion resistant coatings; galvanized coatings will not be acceptable.
  3. Installer: Use manufacturer approved installer having experience with similar installations and complexity.
  4. Delegated Design Professional: Use a professional engineer, registered in the province of the Work and familiar with installations of similar scope and complexity to design under structure support systems and panels to carry design loads indicated.
  5. Design: Provide access floor system designed to support loads and configurations indicated; consisting of modular and removable panels supported by an adjustable height under structure support system; with individual panels capable of being removed by one person using manufacturer's standard lifting device; including all required accessories, quantities and finished floor height necessary for a complete and functional installation.

## 1.8 SITE CONDITIONS

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where access flooring system is indicated to fit between or around walls, columns and other construction contiguous with access flooring; coordinate fabrication schedule with construction progress to avoid delaying the Work; indicate site measurements on shop drawings.
2. Ambient Conditions: Install access flooring system after spaces are fully enclosed, and area of installation is operating under permanent building ambient temperature and humidity.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. ASM Modular Systems Inc.
  2. Camino Modular Systems Inc.
  3. Tate Access Floors.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Structural Performance for Panels: Provide access flooring panels capable of withstanding the following loads and stresses within limits and under conditions indicated, as determined by testing manufacturer's current standard products in accordance with referenced procedures in CISCA Recommended Test Procedures for Access Floors:
  1. Design Load Performance: Provide access flooring systems supported on actual under structure system components capable of withstanding a minimum design load of 1100 kg; signifying that panels will support a concentrated load placed on a 6.5 cm<sup>2</sup> area at any location in the panel without yielding and having a safety factor of 2 without failing; failure is defined as the point at which access flooring system will not take any additional load.
  2. Uniform Load Performance: Provide access flooring systems supported on actual under structure system components capable of supporting a nominal uniform load of 31.15 kN/m<sup>2</sup>.
  3. Rolling Load Performance: Provide access flooring systems capable of withstanding rolling loads of the following magnitude applied to non-perforated panels, with a combination of local and overall deformation not to exceed nominal 1.0 mm after exposure to rolling load over CISCA Path A or B, whichever path produces the greatest top surface deformation, and as follows:
    1. Wheel 1 Rolling Load: Nominal 360 kg for 10 Passes using 75 mm diameter x 46 mm wide wheel.
    2. Wheel 2 Rolling Load: Nominal 270 kg for 10,000 Passes using 250 mm diameter x 100 mm wide wheel.
  4. Impact Load Performance: Provide access flooring systems capable of withstanding an impact load of 68 kg dropped from a height of 915 mm onto a 6.5 cm<sup>2</sup> area using a round or square indenter to any location on the panel.
  5. Panel Drop Test: Provide panel capable of being dropped face up onto to a concrete slab from a height of 915 mm that continues to meet all load performance requirements as previously defined after completion of test.

6. Panel Cut Out: Provide panel having 200 mm diameter cut out capable of withstanding ultimate load of 680 kg without failure applied anywhere on panel.
  7. Flammability of Finishes: Provide access flooring system having a flame spread rating of 5; fuel contribution of 10 and smoke development of 15 when tested in accordance with CAN/ULC S102 and CAN/ULC S102.2.
  8. Combustibility of Support Components and Panels: Provide access floor panels qualifying as non-combustible when tested in accordance with CAN/ULC S135.
2. Structural Performance for Pedestal Assemblies: Provide pedestal assemblies capable of withstanding the following loads and stresses within design limits and conditions indicated in accordance with CISCA testing criteria:
    1. Pedestal Axial Load Performance: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding a 22 kN axial load per pedestal.
    2. Pedestal Overturning Moment Performance: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding an overturning moment of 113 Nm per pedestal applied horizontally at top of pedestal when secured to subfloor.
    3. Provide a means of levelling and locking the assembly at a selected height and that requires deliberate action to change height setting and prevents displacement as a result of vibration.
    4. Ultimate Load Carrying Capacity: Not less than twice design strength.
  3. Stringers: Provide stringer components capable of withstanding the following loads and stresses within design limits and conditions indicated:
    1. Stringer Concentrated Load Performance: Provide stringers, without panels in place, capable of withstanding a concentrated load of 890 N at center of span with a permanent set not to exceed 0.25 mm in accordance with CISCA testing criteria.
    2. Stability: Assembly to remain completely braced and rigid after a maximum of eight abutting panels are removed.
  4. Grounding: Provide direct positive contact to components for safe continuous electrical grounding of entire access flooring system to achieve a maximum panel to under structure resistance of not more than 10 ohms.
  5. Static Electricity Control: Provide resistance range for flooring materials from a minimum of 0.5 mega ohms to a maximum of 20,000 mega ohms, with maximum electrical resistance measured from top of panel to grounded subfloor; exposed metal will not be allowed at the wearing surface of the floor.
  6. Earthquake Load Performance: Provide access flooring capable of withstanding a lateral seismic force (Fp) in seismic zone applicable to this Project, in accordance with requirements provincial Building Code and Authority Having Jurisdiction.

### 2.3 SYSTEM DESCRIPTION

1. Panels: Provide panels that are fully interchangeable except those altered to meet special installation conditions, and as follows:
  1. Panel Type: Corrosion protected steel panel with light weight cementitious core.
  2. Module Size: 610 mm x 610 mm.
  3. Top of Panel Finish: Factory applied carpet tile as specified in Section 09 68 13 – Tile Carpeting.
  4. Underside and Edge Panel Finish: Baked on, static deposited, corrosion resistant epoxy finish, colour selected from manufacturer's standard range.
2. Pedestals: Manufactured from corrosion resistant steel, all welded construction with adjustable height range to suit finished floor height and pedestal base adhesive or mechanical fastener, forming a part of manufacturer's standard access flooring system.

3. Stringers: Manufactured from corrosion resistant steel, mechanically fastened to pedestal to provide positive electrical contact; connection based on gravity or spring action are not acceptable and forming a part of the manufacturer's standard access flooring system.
4. Accessories: Provide premanufactured components meeting manufacturer's system requirements in configurations and locations as indicated on Drawings, and as follows:
  1. Power, Voice and Data Service Modules: high-capacity receptacle boxes with knockouts, duplex receptacles, voice and data interface plates, having grommets and hinged lid to suit floor finish requirements.
  2. Cable Tray: Premanufactured drop in cable tray forming a part of access flooring manufacturer's standard system.
  3. Steps: Premanufactured steps and handrails forming a part of access flooring manufacturer's standard system having fascia plate, perimeter supports, grommets and other components required for a complete installation.
  4. Vertical Closures (Fascia): Provide manufacturer's standard metal closure plates with factory applied finish where under floor cavity is not enclosed by abutting walls or other construction.
  5. Perimeter Support: Provide manufacturer's standard method for supporting panel edge and form transition between access flooring and adjoining floor covering at same level as access flooring.

## 2.4 FINISHES

1. Apply finishes in factory after products are fabricated.
2. Protect finishes on exposed surfaces with protective covering before shipment.
3. Factory Primed Concealed Surfaces: Protect concealed aluminum surfaces that will be in contact with plaster, concrete or masonry surfaces, and dissimilar metals when installed using shop applied zinc-molybdate primer to contact surfaces, minimum dry film thickness of 0.05 mm.

## 3 Execution

### 3.1 EXAMINATION

1. Verify that concrete sealers (if used) are compatible with pedestal adhesives before starting installation of access flooring systems.
2. Verify that subfloor is dry and free of any surface irregularities that could reasonably be anticipated to adversely affect access flooring system appearance or performance before starting installation of access flooring systems.

### 3.2 INSTALLATION

1. Install components in accordance with access flooring system manufacturer's written instructions including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
2. Pedestals and Stringers:
  1. Arrange pedestal assemblies to meet grid spacing required.
  2. Secure base plate to concrete floor with mechanical fasteners after adhesive has cured.
  3. Install additional pedestal assemblies where grid pattern is disturbed by columns, walls, ramps, openings, and steps, and at cut outs that impair floor load capacity.
  4. Install stringers rigidly brace floor pedestals four ways.
3. Floor Panels:
  1. Install floor panels solidly on pedestals, level to maximum variation over entire floor of 1:2000.
  2. Install step tread panels similar to floor panels, securely fixed.
  3. Seal site cuts with plastic angles or channels; exposed cut edges will not be permitted.



4. Fascia Panels:
  1. Install fascia panels at exposed sides step risers where indicated.
  2. Secure panels to continuous angles mechanically secured to structural floor and to edge of floor panels.
  3. Install metal trim at intersection of fascia panels and access floor and at abutting floors, walls and columns.
5. Railings:
  1. Extend railing posts through floor panels to structural floor below, set into and secure to flanged fittings bolted to structural floor.
  2. Bolt posts in position at floor panels with retaining floor collar.
  3. Install railings at walls set into flanged fittings bolted to walls.
  4. Electrically insulate railings from, or directly ground to, access flooring system.
6. Provide electrical grounding connectors and arrange for connection by Division 26 – Electrical.
7. Adjust floor panel system for smooth, quiet operation.

### 3.3 SITE QUALITY CONTROL

1. Manufacturer's Site Services:
  1. Manufacturer's representative shall review work of this Section involving handling, installation, protection and cleaning, and submit written reports in acceptable format to verify compliance of work with manufacturer's written installation instructions and shop drawings.
  2. Provide manufacturer's site services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  3. Schedule site visits to review work at following stages:
    1. After delivery and storage of products, and when preparatory work affecting this Section is complete, before installation begins.
    2. Twice during progress of work; at 25% and 60% complete.
    3. At completion of work, after cleaning is completed.
  4. Submit written reports within three (3) working days of review to Consultant.

### 3.4 CLOSEOUT ACTIVITIES

1. Cleaning: Perform cleaning after installation to remove construction and accumulated environmental dirt as required by Section 01 74 23 – Final Cleaning, and as follows:
  1. Clean surfaces after installation using manufacturer's recommended cleaning procedures using only manufacturer recommended cleaning products.
  2. Remove surplus materials, rubbish, tools and equipment barriers and dispose of legally off site.
2. Protection: Protect access floor in accordance with manufacturer's instructions, using 19 mm plywood with taped (duct tape) joints, until Substantial Performance of the Work to prevent damage to finished surfaces.

**END OF SECTION**

## 1 General

### 1.1 SUMMARY

1. This Section specifies requirements for labour, materials, tools and other equipment, services and supervision required for surface preparation and site painting of exposed exterior and interior items and surfaces to the requirements of the Master Painter's Institute (MPI) Specifications Manual.
2. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections, and as follows:
  1. Surface preparation of substrates includes cleaning, small crack repair, patching, caulking, and making good surfaces and areas.
  2. Surface preparation and prime painting surfaces for wall coverings before installation in accordance with wall covering manufacturer's recommended preparation requirements.
  3. Prime painting and back-priming of surfaces except where pre-primed with an MPI approved primer under other Sections of work.
3. Paint exposed and semi-exposed items and surfaces, except where Specifications indicate that the surface or material is not painted or is to remain natural, and as follows:
  1. Paint item or surface same as similar adjacent materials or surfaces where item or surface is not specifically mentioned.
  2. Consultant will select from standard colours and finishes available where a colour of finish is not indicated.
  3. Painting includes site painting of exposed bare and covered conduit, pipes and ducts including colour coding, hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory applied final finish.
  4. Painting of semi-concealed areas such as inside of light troughs and valances, behind grilles, and projecting edges above and below sight lines
  5. Floating Ceilings: Paint walls for full height above floating ceiling.
  6. Stencil painting of patterns, lines, letters, or symbols indicated on Drawings.
  7. Painting and finishing of exposed to view elevator equipment and components including doors and door frames unless pre-finished.
  8. Painting of exposed to view mechanical heating, ventilating and plumbing services, and equipment such as ducts, sprinkler piping, and electrical work to extent specified unless prefinished.
  9. Provision of safe and adequate ventilation as required over and above temporary ventilation supplied by Contractor, where toxic, volatile, or flammable materials are being used.
  10. Touch-ups and site painting necessary to complete work shown, scheduled, or specified.

### 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing Materials (ASTM International):
  1. ASTM D16-19, Standard Terminology for Paint, Related Coatings, Materials, and Applications
  2. ASTM E84-21a, Standard Test Method for Surface Burning Characteristics of Building Materials
  3. ASTM F1869-16a, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

3. Canadian Standards Association (CSA Group):
  1. CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction
4. Canadian General Standards Board (CGSB):
  1. CGSB 1 Series of Standards contained in the MPI Manual Description of Products, for products forming a part of the specified systems
  2. CAN/CGSB 85.10-99, Protective Coatings for Metals
  3. CAN/CGSB 85.100-93, Painting
1. The Master Painters Institute (MPI):
  1. New Surfaces: Architectural Painting Specification Manual
2. The Society for Protective Coatings (SSPC):
  1. Coating Materials Guidelines
  2. Surface Preparation Guidelines
  3. Application, Inspection and Quality Control Guidelines

#### 1.4 DEFINITIONS

1. Gloss Levels: Standard coating terms defined by MPI Manual apply to products of this Section as follows, and used on Drawings to designate required gloss levels for indicated areas:

Gloss Level 1 (G1):	A traditional matte finish – flat with a gloss max. 5 units at 60° max and 10 units at 85°.
Gloss Level 2 (G2):	A high side sheen flat – ‘a velvet-like’ finish with a gloss max. of 10 units at 60° and 10 – 35 units at 85°.
Gloss Level 3 (G3):	A traditional ‘eggshell-like’ finish with a gloss of 10 – 25 units at 60° and 10 – 35 units at 85°.
Gloss Level 4 (G4):	A ‘satin-like’ finish with a gloss of 20 – 35 units at 60° and a min. of 35 units at 85°.
Gloss Level 5 (G5):	A traditional semi-gloss finish with a gloss of 35 – 70 units at 60°.
Gloss Level 6 (G6):	A traditional gloss finish with a gloss of 70 – 85 units at 60°.
Gloss Level 7 (G7):	A high gloss finish with a gloss of more than 85 units at 60°.

2. Service Areas: Rooms or areas dedicated to fire suppression, plumbing, heating, and ventilation, building integration systems, electrical and communications equipment including the following:
  1. Mechanical Rooms and Closets.
  2. Electrical Rooms and Closets.
  3. Telecommunications Rooms and Closets.
  4. Other rooms or areas containing equipment and systems that provides services to the building.
  5. Exterior areas with exposed pipe, ductwork or conduit providing services to the building.
3. Unfinished Items and Surfaces: Do not paint prefinished items, concealed surfaces (except for back-priming), finished metal surfaces, operating parts, including the following:
  1. Prefinished Items: May include the following factory finished components:
    1. Architectural woodwork.
    2. Acoustical wall panels.
    3. Metal lockers.
    4. Unit kitchens.
    5. Finished mechanical and electrical equipment.

6. Light fixtures.
2. Concealed Surfaces: May include walls or ceilings in the following areas considered as inaccessible spaces:
  1. Furred areas.
  2. Ceiling plenums.
  3. Pipe spaces.
  4. Duct shafts.
3. Finished Metal Surfaces: May include the following:
  1. Anodized aluminum.
  2. Stainless steel.
  3. Chromium plate.
  4. Copper and copper alloys.
  5. Bronze and brass.
4. Operating Parts: May include moving parts of operating equipment and the following:
  1. Valve and damper operators.
  2. Linkages.
  3. Sensing devices.
  4. Motor and fan shafts.
5. Mechanical Ducts or Pipes: May include the following:
  1. PVC or aluminum clad insulated pipes or ducts.
6. Labels: May include the following:
  1. ULC, CSA or other code required labels.
  2. Equipment name, identification, performance rating, or nomenclature plates.

#### 1.5 ADMINISTRATIVE REQUIREMENTS

1. Pre-Installation Meeting: Conduct meeting at Project site in accordance with requirements of Section 01 31 19 – Project Meetings, attended by the Contractor's personnel, the Consultant including mechanical and electrical engineers, the mechanical and electrical Subcontractor, and the painting Subcontractor to discuss:
  1. Mechanical and electrical painting.
  2. Special surface effects.
  3. Coordination of work with work of other Sections.
  4. Protection of finishes.
  5. Acceptability of substrates.
  6. Quality of materials being used for the project.
2. Coordination: Coordinate requirements of this Section with other components of the Work of the Project as follows:
  1. Condition of Substrates: Coordinate correction of defects and deficiencies in substrates that may adversely affect painting work, except for minimal work specified in this section and preparation of surfaces to receive paint and finishes under this section of work, with trades responsible for installation of deficient substrates:
    1. Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates.
    2. Provide information to work of other Sections about characteristics of finish materials to ensure use of compatible primers when requested.

2. Coordination with Other Coating Systems: Coordinate with other coating systems such as intumescent fireproofing coatings, high build coatings and similar materials, and account of work performed by this Section with products specified in other coating specification Sections.
3. Non-Architecturally Exposed Structural Steel Surface Preparation: Coordinate surface preparation and shop priming of non-architecturally exposed structural steel, steel deck, and metal fabrications, metal doors, frames and windows including fittings as specified under those respective sections for type of primer forming a part of the painting system specified in this section and as follows:
  1. Specification sections having steel or metal components requiring applied finishes will prime steel with coatings specified in this section.
  2. Touch-up primer and apply finish coatings specified for steel or metal components.
  3. Failure to coordinate correct shop priming of steel construction will result in the Consultant giving instructions for removal of shop applied primer, and the Contractor assessing costs to the responsible trades.
4. Mechanical and Electrical Finishing: Coordinate requirements for painting and identification of mechanical piping and ducting, and electrical conduits with trades responsible for that part of the work as follows:
  1. Obtain quantity or length of materials requiring applied finishes, and identify which colour is required on each surface from mechanical or electrical contractor.
  2. Prepare surfaces and apply coating systems specified, in colours required for each surface.
  3. Mechanical and electrical contractors will be responsible for application of secondary markings and identification labels.
3. Scheduling: Schedule painting work before installation of miscellaneous hardware, surface fittings, fastenings, fixtures, and trim by other paint applicators including the hanging of doors and installation of door hardware:
  1. Remove, store, and reinstall items that have been installed before start of work of this Section.
  2. Schedule work of this Section with the Contractor to allow for:
    1. Disruption of work of this section by other trades
    2. Disruption of work to other trades by this section
  3. Schedule phased work with the Contractor.
  4. Do not apply final coat of paint until Consultant has had the opportunity to review and adjust tint under actual lighting conditions.

## 1.6 SUBMITTALS

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit list of all painting materials used for the Work to the Consultant for review prior to ordering materials for each paint system indicated, including primers, and as follows:
    1. Material List: An inclusive list of required coating materials indicating each material and cross reference specific coating, finish system, and application; identify each material by manufacturer's catalogue number and classification.
    2. Base Information: Confirmation of manufacturer's ability to supply paint in a variety of base tints, specific to the range of colours being used on this project; indicate colour of base tint used and amount of colourant added to establish Scheduled colours.
    3. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

2. Samples: Provide stepped samples, defining each separate coat, including primers using representative colours required for the project; label each sample for location and application, and as follows:
  1. Samples for Initial Selection: Provide samples for each type of finish coat material specified; Consultant will provide colour chips for surfaces being coated after colour selection.
  2. Drawdown Samples: Provide three (3) drawdown sample charts (cards) for each type, texture and colour of finish specified for verification purposes before ordering paint materials:
    1. Apply paint sample in layers to Opacity Charts, by The Leneta Company until paint colour appearance over black and white areas is identical, or the specified level of opacity for translucent products has been achieved.
    2. Apply paint to Opacity-Display Charts in an even coat as soon as possible after mixing; apply enough layers to make painted area completely opaque, or to the required level of opacity for translucent products.
    3. Order paint only for drawdown cards accepted by Consultant.
    4. Final colour selection is by Consultant.
    5. Resubmit until accepted by Consultant.
    6. Consultant will provide colour chips if alternate colours are selected for rejected cards.
  3. Samples for Verification: When requested by the Consultant, provide samples for each colour and material, with texture to simulate actual conditions, on representative samples of the actual substrate as follows:
    1. Ferrous Metal: 100 mm square or 200 mm long samples of flat metal for each colour and finish.
    2. Painted Gypsum Board: 200 mm long or square samples for each colour and material.
3. Informational Submittals: Provide the following submittals when requested by the Consultant:
  1. Certification: Submit certification reports for paint products indicating that they meet or exceed low VOC and coloured base requirements listed in this Section.
  2. Purchase Orders: Retain purchase orders, invoices, and other documents for verification of compliance with specification and design requirements.
4. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### 1.7 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of paint manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data including specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.
2. Maintenance Materials: Deliver maintenance materials to Owner in quantities indicated and in accordance with Section 01 78 43 – Spare Parts that match products installed; packaged with protective covering for storage, and identified with labels describing contents and building location and as follows:
  1. Paints and Coatings: Minimum of four (4)-4L containers of field colours and four (4)-1 L containers of each accent colour, and all remnants.

#### 1.8 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant:

1. Applicator: Use a firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and as follows:
  1. Having a minimum of three (3) years proven satisfactory experience; show proof of qualifications when requested by Consultant.
  2. Provide a list of the last three comparable jobs including, name and location, specifying authority, start and completion dates and cost amount of the painting work when requested.
  3. Use only qualified journeymen who have a Tradesman Qualification Certificate of Proficiency for painting and decorating work.
  4. Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.
2. Supplier: Obtain primers for each coating system from the same manufacturer as the finish coats and as follows:
  1. Use only paint manufacturers and products as listed under the Approved Products section of the MPI Manual Architectural Painting Specification Manual.
  2. Use only paint manufacturers and products as listed under the Approved Products section of the MPI Manual Architectural Painting Specification Manual as modified by performance requirements listed in this Section.

#### 1.9 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance Requirements: Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
  1. Product name or title of material.
  2. Product description (generic classification or binder type).
  3. Manufacturer's stock number and date of manufacture.
  4. Contents by volume, for pigment and vehicle constituents.
  5. Thinning instructions.
  6. Application instructions.
  7. Colour name and number.
  8. VOC content and sustainable labelling agency identified.
2. Storage and Handling Requirements: Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7°C, in accordance with the following:
  1. Maintain storage containers in a clean condition, free of foreign materials and residue.
  2. Protect from freezing.
  3. Keep storage area neat and orderly.
  4. Remove oily rags and waste daily.
  5. Maintain toxic, volatile, explosive, or flammable materials in a safe environment:
    1. Provide adequate fireproof storage lockers for solvents, drop clothes, rags, and other flammable materials.
    2. Post warning signs, such as NO SMOKING, NO OPEN FLAMES.
    3. Prevent the release of volatile organic compounds (VOC) into the atmosphere.
    4. Prevent fire hazards and spontaneous combustion.
    5. Prevent hazardous spills.
    6. Store materials that constitute a fire hazard (paints, solvents, and drop clothes, etc.) in suitable closed and rated containers and removed from the site on a daily basis.
    7. Comply with requirements of authorities having jurisdiction concerning the use, handling, storage, and disposal of hazardous materials.

6. Provide one (1) 9 kg ABC fire extinguisher with all temporary heating equipment, and in close proximity to where paint and coating materials are being stored.

## 1.10 SITE CONDITIONS

1. Ambient Conditions: Maintain relative humidity at less than 85%, temperatures at least 3°C above dew point, and as follows:
  1. Temperature: Maintain temperature of surfaces and surrounding air between the following temperatures for a minimum of 24 hours before, during and after application or until paints and coatings are fully cured, whichever is greater:
    1. Waterborne paints and coatings: 10° to 32°C.
    2. Solvent thinned paints and coatings: 7° to 35°C.
    3. Maintain temperatures during application and until materials are fully cured.
2. Surfaces Conditions:
  1. Maintain surfaces free from snow, rain, fog, or mist, dampness or wetness that could impair bond; painting may continue during inclement weather if surfaces and areas are enclosed and heated within temperature limits specified above in this Section during application and drying periods.
  2. Maintain surfaces at less than maximum moisture content indicated below; test wood and plaster surfaces using a properly calibrated electronic moisture meter:
    1. Plaster and Gypsum Board: 12% maximum moisture content.

## 2 Products

### 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Benjamin Moore and Co. Limited.
  2. Cloverdale Industrial Protective Coatings.
  3. Dulux Paints.
  4. Para Paints.
  5. PPG Canada Inc., Architectural Finishes.
  6. SICO Inc.
  7. Sherwin-Williams LLC.
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Proprietary Colour Codes: Colour and colour matching is a performance requirement for the project and will be administered as follows:



1. Use of manufacturer's proprietary colour codes is not intended to imply that listed manufacturer's are used to the exclusion of products of other manufacturers listed as Acceptable Products within this Section, or MPI Approved Product listing where Acceptable Products listing is not included.
2. Tinting by other named manufacturers listed as Acceptable Products or within the MPI Approved Product listing is permitted.
2. Quality of Materials: Use only manufacturer's top-line or premium series products when multiple listings from the same manufacturer occur within MPI Approved Product Categories and specific Acceptable Products are not included under the scheduled MPI Architectural Systems Listings in this Section; paint material containers not displaying manufacturer's product identification will not be acceptable:
  1. Provide materials from the same manufacturer within the specified MPI Architectural Systems or Acceptable Products listings.
  2. Provide materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents) in accordance with the MPI Approved Product listing, as a minimum; include additional requirements of this Section for base tint and colourant limitations.
  3. Provide other materials (linseed oil, shellac, thinners) not specifically listed of the highest quality product of an approved manufacturer listed in the MPI Manual and that are compatible with other coating materials.
3. Environmental Performance: Listing of Acceptable Products and manufacturers in this Section is based on product listings that have provided proof of the following performance requirements for paints and coating systems:
  1. Use only paints and coatings that have low or ultra-low VOC content tint bases and colourants to the greatest extent possible, and as follows:
    1. Materials must not be formulated or manufactured with formaldehyde, halogenated or aromatic solvents, and heavy metals such as mercury, lead, cadmium, and chromium.
    2. Materials must have a flash point of 61.0°C or greater.
    3. Paints and coatings must not contain VOC's in excess of limits required by sustainable design requirements.
    4. Clearly label containers with Green SEAL sustainable labelling mark required for LEED® submissions.
    5. Use paint materials that have good flowing and brushing properties, and that dry or cure free of blemishes or sags.
  2. Use paint bases that require no more than 90 grams/L of colourant to achieve the scheduled colours; manufacturers that offer ultra low or no VOC content colourants will be given preference.
  3. Use paint bases that when combined with colourant do not exceed 100 g/L VOC; no exceptions where VOC compliance requirements are provided in this Section.
  4. Paints that readily scuff, burnish, varnish or oxidize on contact after manufacturer's recommended curing period will not be acceptable for use on this project.
4. Material Compatibility: Provide primers and finish coat materials that are compatible with one another and with substrates required for conditions of service and application, as demonstrated by manufacturer based on testing and site experience:
  1. Use paint materials that have good flowing and brushing properties, and that dry or cure free of blemishes or sags.
  2. Provide paints and coatings that meet flame spread and smoke developed ratings designated by local Code requirements and Authority Having Jurisdiction.

## 2.3 EQUIPMENT

1. Painting and Decorating Equipment:

1. Use decorating equipment that meets or exceeds best trade standards for type of product and application.
2. Use spray painting equipment of capacity suited to the type and consistency of paint or coating being applied; kept clean and in good working order.

## **2.4 MIXING AND TINTING**

1. Colours: Match colours listed on Drawings.
2. Multiple Paint Base Tints: Use only paint systems that offer multiple tint bases that minimize addition of colourants; transparent bases will not be accepted as an acceptable tint base where manufacturer listings within the MPI Approved Products listing have multiple listings.
3. Mixing: Provide ready mixed paints; re-mix paints immediately prior to and during application to maintain colour and gloss uniformity:
  1. Mix paste, powder or catalyzed paints or coatings in strict accordance with manufacturer's written instructions.
  2. Perform all colour tinting operations before delivery to site; limit amount of colourant added to base tint as indicated in this Section.
  3. Add thinner, where allowed by manufacturer, of type and quantity in accordance with paint manufacturer's recommendations.

## **3 Execution**

### **3.1 CONDITION OF SURFACES**

1. Apply paint only to dry, clean, properly cured and adequately prepared surfaces in areas where dust is no longer generated by construction activities such that airborne particles will not affect the quality of finished surfaces.
2. Thoroughly examine and test substrates for conditions adversely affecting application of coatings prior to commencement of work of this section:
  1. Report in writing to the Contractor indicating measures required to correct affected work of this section, and informing other Sections responsible for the condition of substrates of requirements for correcting defects and deficiencies:
    1. Notify responsible substrate trade contract installer of conditions that become apparent after application of first coat of paint requiring corrective action.
    2. Starting of finish painting of defective surfaces, such as gypsum board, will indicate acceptance of substrate and costs of repairing defects will be borne by the paint applicator of this Section including repainting of entire defective surface; touch-up painting will not be allowed.
  2. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
  3. Notify Consultant about anticipated problems when using the materials specified over substrates primed by others.
  4. Start of painting will be construed as acceptance of surfaces and conditions within a particular area.

### **3.2 PREPARATION OF SURFACES**

1. Provide a minimum lighting level of 325 Lux on surfaces where paint or coatings are being applied; and supply temporary heat and ventilation, scaffolding and platforms, and housekeeping services as required to complete the work of this Section, and as follows:
  1. Maintain adequate continuous ventilation and sufficient heating facilities to maintain ambient air and substrate temperatures as indicated above in this Section.
  2. Provide supplemental ventilating and heating equipment if existing system is inadequate to meet minimum requirements.

2. Prepare substrate surfaces in accordance with MPI Manual requirements including but not limited to remaining items listed in this article.
3. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted:
  1. Provide surface applied protection before surface preparation and painting where removal is impractical or impossible because of size or weight of the item.
  2. Reinstall items removed using workers skilled in the trades involved after completing painting operations in each space or area.
4. Remove oil and grease then clean substrates of substances that could impair bond of the various coatings before applying paint or other surface treatments:
  1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
  2. Clean and prepare surfaces according to manufacturer's written instructions for each particular substrate condition and as specified.
5. Provide barrier coats over incompatible primers or remove and re-prime substrate where paint applicator for this Section failed to coordinate use of MPI Manual recommended primers and surface preparation techniques.
6. Clean ungalvanized ferrous metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances using solvent or mechanical cleaning methods that comply with SSPC recommendations appropriate to surface and exposure location:
  1. Blast steel surfaces clean as recommended by paint system manufacturer.
  2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
  3. Touch up bare areas and shop applied prime coats that have been damaged; wire brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as shop coat.
7. Clean galvanized surfaces with non-petroleum-based solvents so surface is free of oil and surface contaminants, mechanically remove pre-treatment materials from galvanized sheet metal fabricated from coil stock.
8. Mix and prepare paint materials according to manufacturer's written instructions:
  1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
  2. Stir material before application to produce a mixture of uniform density.
  3. Stir as required during application to maintain consistent tint density.
  4. Do not stir surface film into material, remove surface film and strain material before using.
  5. Use only thinners approved by paint manufacturer and only within recommended limits.
  6. Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied.
  7. Tint undercoats to match the colour of the finish coat; but provide sufficient differences in shade of undercoats to distinguish each separate coat.
9. Protect adjacent surfaces and areas from painting operations and damage by drop cloths, shields, masking, templates, or other suitable protective means.
10. Correct, refinish, or replace any damage caused by failure to provide adequate protection to adjacent surfaces.
11. Sand, clean, dry, etch, neutralize, or test all surfaces using adequate illumination, ventilation, and temperature requirements in accordance with manufacturer's written instructions and the MPI Manual.

### 3.3 APPLICATION

1. Apply paint according to manufacturer's written instructions, use applicators and techniques best suited for substrate and type of material being applied, and in accordance with MPI Manual Premium Grade finish requirements, except where additional requirements have been specified.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term exposed surfaces include areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place; extend coatings in these areas as required, to maintain system integrity and provide desired protection, and as follows:
  1. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces.
  2. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
  3. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
  4. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
  5. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
  6. Finish interior of wall and base cabinets and similar site-finished casework to match exterior.
  7. Sand lightly between each succeeding coating of enamel or varnish.
5. Apply first coat to surfaces that have been cleaned, pre-treated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration, and as follows:
  1. Apply paint and coatings within an appropriate time frame after cleaning where environmental conditions encourage flash rusting, rusting, contamination, or the manufacturer's paint specifications require earlier applications.
  2. The number of coats and film thickness required are the same regardless of application method, except that dark tinted colours will require a minimum of four (4) coats with an additional clear urethane or water based light industrial type of coating applied in high traffic areas.
  3. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
  4. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
  5. Omit primer over metal surfaces that have been shop primed and touch-up painted.
  6. Apply additional coats until paint film is of uniform finish, colour, and appearance if undercoats, stains, or other conditions show through final coat of paint, giving special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
  7. Allow sufficient time between successive coats to permit proper drying.
  8. Do not recoat surfaces until paint has dried to where it feels firm and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
6. Apply paints and coatings by brush, roller, spray, or other application methods according to manufacturer's written instructions and as follows:
  1. Application methods:

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required and as follows:
  1. Apply paint using brush or roller unless Consultant has given written acceptance for use of spray equipment and methods.
  2. The Consultant may at any time prohibit the use of spray painting for such reasons as carelessness, poor masking, or protective measures, drifting paint fog, disturbance to other trades or failure to obtain a dense, even, opaque finish.
  3. Back roll sprayed surface progressively.
2. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness recommended by the manufacturer.
3. Sand and dust between each coat to provide an anchor for next coat and to remove defects visible from a distance up to 1220 mm.
7. Hollow Metal Doors and Frames: Sand to remove blemishes and fill surface dimples, prime using coating compatible with finishes.

### 3.4 MECHANICAL AND ELECTRICAL PAINT APPLICATION

1. Painting of mechanical and electrical work, including hangers and supports is limited to items exposed in service areas.
2. Paint mechanical items including the following:
  1. Un-insulated metal piping; interior and exterior.
  2. Un-insulated plastic piping; interior and exterior.
  3. Pipe hangers and supports, interior and exterior.
  4. Tanks that do not have factory-applied final finish.
  5. Visible portions of internal surfaces of metal ducts without liner, behind air inlets and outlets
  6. Duct, equipment, and pipe insulation having paintable service jacket or other paintable jacket material; do not paint PVC or aluminum clad insulated ducts.
  7. Mechanical equipment that is indicated to have a factory primed finish for site painting which may include the following:
    1. Exterior items: Louvers and grilles, air handling units, mechanical ductwork, metal chimney stacks, goosenecks, roof jacks and roof vents.
    2. Interior items: Un-insulated valves, valve handles, boilers, fan guards, heat exchangers, cold fluid tanks, hot fluid tanks, integral pump bases, water chiller units, pumps, brine tanks, air handling units and plenums.
8. Painting and colour coding is required on substrates in colours as listed in Division 20 – Mechanical Support for system identification.
3. Paint electrical items including the following:
  1. Switchgear.
  2. Panel boards.
  3. Electrical Conduit and cable; interior and exterior
  4. Electrical equipment which is required to be prefinished in coded colours in accordance with electrical colour coding requirements specified in Division 26 – Electrical.
  5. Painting and colour coding is required on substrates in colours as listed in Division 26 – Electrical for system identification.
4. Locations:
  1. Painting and colour coding is required at locations specified below in this Section, on substrates and by methods indicated.

2. Exposed in Services Areas: Includes but is not limited to, rooms and areas containing equipment relating to mechanical systems, sprinkler systems, electrical systems, boiler and heating systems, air handling systems, and similar rooms.
  3. Exposed in Finished Areas: Includes all other rooms not listed above; mechanical and electrical work will be left exposed as an architectural feature in areas where there are no ceilings.
  4. Semi-Concealed Spaces: Includes all non-exposed but accessible spaces behind ceilings, walls, and floors, including exposed spaces that will be semi-concealed at some future time.
  5. Permanently Concealed Spaces: Includes all non-exposed and permanently inaccessible spaces behind ceilings, walls, and floors, including exposed spaces which will be permanently concealed at some future time.
  6. Exposed to Exterior: Includes all exposed exterior locations.
5. Methods:
1. Painting and colour coding by methods specified below, are required on substrates and at locations indicated below in this Section.
  2. Method P1 Full Colour Coding for Mechanical Piping and Equipment:
    1. Primary Colour Coding: Paint substrates in their entirety in required primary colour for each type of service in accordance with Colour Coding Requirements. Use applicable 3 coat finish system.
  3. Method P2 Intermittent Colour Coding for Mechanical Piping:
    1. Paint System: Use one coat semi-gloss enamel or machinery enamel, suitable for type of substrate and surface temperature.
    2. Primary Colour Coding: Apply paint in required primary colours for each type of service in accordance with Colour Coding Requirements specified in Division 22 – Plumbing, Mechanical Systems Identification.
  4. Method P3 Full Painting in Un-coded Colours:
    1. Paint substrates in their entirety. Use applicable 3 coat finish system.
    2. Except as otherwise specified below, make colours the same as wall or ceiling background colours.
    3. Where interior mechanical and electrical work will be left exposed as an architectural feature, for bidding purposes, colour scheme will include a maximum of 2 colours with approximately 50% deep colour tones, excluding colours for mechanical piping which require primary colour coding as specified under Method P1.
    4. Where exterior mechanical and electrical work requires painting, for bidding purposes, colour scheme will include a maximum of 2 colours with approximately 50% deep colour tones, excluding colours for mechanical piping which require primary colour coding as specified under Method P1.
  5. Method P4 No Painting and Colour Coding:
    1. Painting and colour coding are not required.
  6. Paint natural gas piping painted yellow in interior and exterior locations; whether concealed, semi-concealed or exposed; do not apply other colour applied to gas piping, except as stated for banding identification only or where piping is pre-coloured.

### 3.5 FINISHING

1. Refer to Drawing A141 – Finishes Plan for room paint finishes, and as follows:
  1. Paint wall surfaces using Gloss Level G3.
  2. Paint ceiling surfaces using Gloss Level G1.
  3. Paint doors, frames and trim using Gloss Level G5.
  4. Confirm with Consultant where Gloss Level is not indicated before ordering materials.

### 3.6 CLOSEOUT REQUIREMENTS

1. Adjusting: Clean and re-install all hardware items that were removed before painting operations were undertaken, ensuring that tagged or labelled items are returned to the exact position from which they were removed and as follows:
  1. Clean, prime and re-paint all bolts, nuts, and fasteners after torqueing or re-tightening following specified paint finish.
  2. Remove protective coverings and warning signs as soon as possible after operations cease.
  3. Protect freshly painted surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
  4. Restore areas used for storage, cleaning, mixing, and handling of paint to clean condition as approved by Consultant.
2. Cleaning: Perform final cleaning in accordance with Section 01 74 23 - Final Cleaning, and as follows:
  1. Remove all paint where spilled, splashed, splattered, or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
  2. Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials, and debris.
  3. Remove combustible rubbish materials and empty paint cans each day and safely dispose of it in accordance with requirements of authorities having jurisdiction.
  4. Clean equipment and dispose of wash water or solvents, and other cleaning and protective materials (rags, drop cloths, masking papers, and etcetera), paints, thinners, paint removers and strippers in accordance with the safety requirements of authorities having jurisdiction.
3. Protection: Protect newly painted exterior surfaces from rain and snow, condensation, contamination, dust, salt spray and freezing temperatures until paint coatings are completely dry and as follows:
  1. Allow for curing periods that exceed manufacturer's recommended minimum time requirements.
  2. Erect barriers or screens and post signs to warn of or limit or direct traffic away or around work area as required.

### 3.7 EXTERIOR PAINT SCHEDULE

1. Paint exterior surfaces in accordance with the MPI Manual painting systems listed in this Section.
2. EXT 2.1 – Asphalt Surfaces (Zone/Traffic Marking For Exterior Drive and Parking Areas, Game Lines, Etc.):
  1. EXT 2.1B – Alkyd Zone/Traffic Marking.
3. EXT 5.3 – Galvanized Metal (Doors, Frames, Railings, Misc. Steel, Pipes, Overhead Decking, Eavestroughs (gutters), Downpipes, Ducts, Etc.):
  1. EXT 5.3C – Epoxy (over epoxy primer) (High Contact/Traffic)
  2. EXT 5.3H – Latex (over w.b. galvanized primer) (Low Contact/Traffic).

### 3.8 INTERIOR PAINT SCHEDULE

1. Paint interior surfaces in accordance with the MPI Manual painting systems listed in this Section.
2. INT 5.3 – Galvanized Metal (Doors and Frames):
  1. INT 5.3N – Institutional Low Odour / VOC (over w.b. galvanized primer, G5, (High Contact/Traffic Areas):

1. MPI #134 – Primer, Galvanized, Water Based.
2. MPI #147 – Latex, Interior, Institutional Low Odor/VOC.
3. INT 6.3 – Dressed Lumber (Telecommunication Panel):
  1. INT 6.3S – Fire Retardant, Clear, S.B.:
    1. MPI #62 - Fire Retardant Coating, Interior, Clear (ULC/ULC Approved).
4. INT 9.2 – Plaster and Gypsum Board (Gypsum Wallboard, Drywall, “Sheet Rock” Type Material, and Texture Finishes, Etc.):
  1. INT 9.2M – Institutional Low Odour/VOC (over w.b. primer sealer, low VOC primer) G1, Ceilings:
    1. MPI #149 – Primer Sealer, Interior, Institutional Low Odor/VOC.
    2. MPI #143 – Latex, Interior, Institutional Low Odor/VOC.
  2. INT 9.2M – Institutional Low Odour/VOC (over w.b. primer sealer, low VOC primer) G3, Walls:
    1. MPI #149 – Primer Sealer, Interior, Institutional Low Odor/VOC.
    2. MPI #145 – Latex, Interior, Institutional Low Odor/VOC.

### 3.9 COLOUR SCHEDULE

1. PT-1 Dulux, Silver Feather, DLX1002-1 (Main Paint Colour).
2. PT-2 Dulux, Morning Song, DLX1034-1 (Accent at Corridor).
3. PT-3 Dulux, Misty Surf, DLX1034-4 (Accent at Corridor).
4. PT-4 Dulux, Zombie, X1010-7 (Doors and Frames).

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of impact resistant wall protection including, but not limited to, corner guards.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting work of this section:
  1. Product Data: Submit product data including construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact resistant wall protection unit.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.4 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work, and as follows:
  1. Include recommended methods and frequency of maintenance for maintaining optimum condition of steel finishes under anticipated traffic and use conditions.
  2. Include precautions against using cleaning materials and methods that may be detrimental to steel finishes and performance.

### **1.5 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Installer: Use installers that have completed the manufacturer's authorized training program and are approved for both installation and maintenance of specified impact resistant wall protection.
  2. Manufacturer: Obtain impact resistant wall protection units through one source from a single manufacturer.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

1. Delivery and Acceptance Requirements: Deliver materials in unopened factory packaging to the project site in accordance with manufacturer's recommendations.
2. Storage and Handling Requirements: Store impact resistant wall protection units in original undamaged packages and containers inside well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

### **1.7 SITE CONDITIONS**

1. Site Measurements: Verify actual locations of walls, columns, and other construction contiguous with impact resistant wall protection units by site measurements before fabrication and indicate measurements on shop drawings.

2. Ambient Conditions: Deliver and install impact resistant wall protection units after building is enclosed and weatherproof, when wet work is complete and dry, and HVAC system is operating and maintaining temperature at building operating conditions for not less than 72 hours before beginning installation and for the remainder of the construction period.

## **2 Products**

### **22.1 MANUFACTURERS**

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Construction Specialties.
  2. Frost Products.
  3. Inpro Corporation.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### **2.2 MATERIALS**

1. Fasteners: Aluminum, nonmagnetic stainless steel, or other non-corrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security type fasteners where exposed to view.
2. Adhesive: Type recommended by manufacturer for use with material being adhered to substrate indicated.

### **2.3 CORNER GUARDS**

1. Surface Mounted, Metal Corner Guards: Fabricated from single piece, formed metal with eased edges; bend angle turn to match wall condition, and as follows:
  1. Material: Stainless steel, Type 304.
  2. Thickness: Minimum 1.519 mm.
  3. Finish: Directional satin, No. 4.
  4. Wing Size: Nominal 89 mm x 89 mm.
  5. Corner Radius: 3 mm.
  6. Mounting: Adhesive or flat head, countersunk screws through factory drilled mounting holes.

### **2.4 WALL PROTECTION**

1. Decorative Protection Panels (WP-1):
  1. Panel Core: Class A, fire-rated treated fibreglass core.
  2. Laminate Grade: Grade H1, 1.72 mm.
  3. Trims: Aluminum clean anodized end cap and outside trims as follows:
    1. End Cap Profile:
      1. HardStop AT40 by Formica Group.
    2. Outside Corner Profile (where two decorative panels meet):
      - 2.1. HardStop AT20 by Formica Group.
  4. Colour and Finish: Winter Sky 8792.
  5. Basis-of-Design Products: HardStop Decorative Protection Panels by Formica Group.

## **2.5 FABRICATION**

1. Fabricate impact resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.
2. Assemble components in factory to greatest extent possible to minimize site assembly. Disassemble only as necessary for shipping and handling.
3. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven colouration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

## **2.6 METAL FINISHES**

1. Remove tool and die marks and stretch lines or blend into finish.
2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
3. Passivate and rinse surfaces when polishing is completed.
4. Remove embedded foreign matter and leave surfaces chemically clean.
5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## **3 Execution**

### **3.1 EXAMINATION**

1. Examine substrates and wall areas for compliance with manufacturer's requirements for installation tolerances and other conditions affecting performance of work.
2. Examine walls that will receive impact resistant wall protection and verify that blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers for impact resistant wall protection units attached with adhesive.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

1. Complete finishing operations, including painting, before installing impact resistant wall protection system components.
2. Clean substrate to remove dust, debris, and loose particles before installation.

### **3.3 INSTALLATION**

1. Install impact resistant wall protection units level, plumb, and true to line without distortions.
2. Install decorative protection panels in accordance with manufacture's written installation instruction at locations and mounting heights indicated on Drawings. Install specified trims as recommended by manufacturer using manufacturer's recommended clear silicone adhesive to adhere trims.
3. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
4. Install impact resistant wall protection units in locations and at mounting heights indicated on Drawings.

### **3.4 CLOSEOUT ACTIVITIES**

1. Cleaning:

1. Clean installed impact resistant wall protection products and accessories using standard, ammonia-based household cleaning agents immediately after installation completion.
2. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

**END OF SECTION**

## 1.1 SUMMARY

1. This Section specifies requirements for supply and installation of toilet accessories.

## 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

## 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A153/A153M-23, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. ASTM A366/A366M-97e1, Standard Specification for Commercial Steel (CS) Sheet, Carbon (0.15 Maximum Percent) Cold-Rolled
  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 A666-23, Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar
  5. ASTM F446-19(2023), Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area
3. Canadian General Standards Board (CGSB):
  1. CAN/CGSB-12.5-M86, Mirrors, Silvered
4. Canadian Standards Association (CSA Group):
  1. CSA/ASC B651:23, Accessible Design for the Built Environment

## 1.4 ADMINISTRATIVE REQUIREMENTS

1. Coordination: Coordinate accessory locations with other affected work to prevent interference with clearances required for barrier-free access, proper installation within substrate, blocking requirements, adjustment, operation, cleaning, and servicing of accessories including the following:
  1. Reinforcement and backing locations indicated on Drawings.
  2. Delivery of inserts and anchoring devices set into concrete or masonry as required to prevent delay to work of this Section.

## 1.5 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.6 PROJECT CLOSEOUT SUBMISSIONS

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

### 1.7 QUALITY ASSURANCE

1. Regulatory Requirements: Install toilet accessories in accordance with CAN/CSA B651.
2. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Manufacturer: Obtain toilet accessories and products from a single manufacturer.

### 1.8 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance: Deliver toilet accessories in manufacturer's original, undamaged packaging, clearly marked for contents and location within building.
2. Storage and Handling: Store and handle toilet accessories in accordance with manufacturer's written recommendations.

### 1.9 WARRANTY

1. Manufacturer's Warranty: Provide manufacturer's standard two (2) years warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

## 2 Products

### 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. ASI American Specialties Inc.
  2. Bobrick Washroom Equipment of Canada Ltd.
  3. Bradley Corporation
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitution Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Fastener and Mounting Requirements: Install grab bars to withstand a minimum 1.3 kN downward shear force when tested in accordance with ASTM F446; provide fasteners and mountings of types suitable for substrates, and as required for permanent and durable installation.
2. Labels: Provide unobtrusive stamped manufacturer logo on exposed surfaces; with printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number mounted to non-exposed faces.
3. Surface Mounted Units: Provide units having tight seams and joints, and with exposed edges rolled; doors and access panels having continuous stainless-steel hinges; and concealed anchorage where possible.
4. Recessed Mounted Units: Provide units having welded construction, without mitred corners; doors and access panels having full-length, stainless-steel hinges and anchorage fully concealed when unit is closed.

5. Framed Glass Mirror Units: Provide frames for glass mirror units designed to protect glass edges from damage, and as follows:
  1. Mirror Backing: Backing and support system that permits rigid, tamper resistant glass installation, and prevents moisture accumulation consisting of minimum nominal 0.8 mm galvanized steel sheet same size as full mirror size with non-absorptive filler material; corrugated cardboard is not an acceptable filler material.
  2. Mirror Unit Hangers: Provide rigid, tamper and theft resistant, heavy duty wall hanging device consisting of one-piece galvanized steel and spring action locking mechanism to hold mirror unit in position with no exposed screws or bolts.

## 2.3 MATERIALS

1. Stainless Steel: Type 304, stretcher levelled stainless steel sheet in accordance with ASTM A666; minimum nominal thickness as established by product type and manufacturers standard.
2. Sheet Steel: Steel: Cold rolled, commercial quality, stretcher levelled steel sheet in accordance with ASTM A366/A366M; minimum nominal thickness as established by product type and manufacturers standard; surface preparation and metal pre-treatment as required for applied finish.
3. Galvanized Steel Sheet: Minimum Z180 coating designation cold rolled commercial quality, stretcher levelled galvanized steel sheet in accordance with ASTM A653/A653M; minimum nominal thickness as established by product type and manufacturers standard.
4. Mirror Glass: In accordance with CGSB 12.5; Type 1B for high humidity use, 6 mm nominal thickness, with silvering, electroplated copper coating, and protective organic coating.
5. Fasteners: Manufacturer's standard for installation; through bolts for mounting to toilet partitions; expansion anchors of type designed to accept anticipated loads, and as follows:
  1. Galvanized Steel Mounting Devices: In accordance with ASTM A153/A153M, hot dip galvanized after fabrication.
  2. Screws, Bolts, and other Devices: Same material as accessory unit, tamper, and theft resistant when exposed, and galvanized steel when concealed.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

1. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer; install toilet accessories level, plumb, and firmly anchored in locations and at heights indicated.
2. Conform to mounting heights indicated on Fixture Mounting Schedule as indicated on Drawings and meeting accessibility requirements listed in CAN/CSA B651; confirm locations prior to site installation.
3. Secure mirrors to walls using concealed, tamper resistant hangers, toggle bolts, or screws; set mirrors level, plumb, and square at locations indicated, centred over lavatory.
4. Install recessed fixtures in fire rated partitions to maintain required fire rating of assembly by installing 16 mm Type fire rated gypsum board completely around units.
5. Install and secure fixtures rigidly in place using tamper proof headed screws and bolts for fasteners and as follows:

1. Stud Walls: Install steel back plate to stud prior to gypsum board finish; provide threaded studs or plugs in back plates.

### 3.3 CLOSEOUT ACTIVITIES

1. Adjusting: Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
2. Cleaning:
  1. Remove temporary labels and protective coatings.
  2. Clean and polish exposed surfaces in accordance with manufacturer's written recommendations.
3. Demonstration and Training: Instruct Owner in proper adjustment, operation, and refilling procedures.

### 3.4 TOILET ACCESSORY SCHEDULE

Tag No.	Description and Products
P001	Surface Mounted Framed Mirrors: <ul style="list-style-type: none"> <li>- Finish: Type 304 stainless steel.</li> <li>- Type: Flat Mirror.</li> <li>- Dimensions (Overall): 610 mm wide x 910 mm high.</li> <li>- Basis-of-Design Products: Frost Products Ltd., 941-24x36</li> </ul>
P005	Collapsible Coat Hooks: <ul style="list-style-type: none"> <li>- Finish: Type 304 stainless steel, brushed finish.</li> <li>- Type: Safety Coat Hook.</li> <li>- Dimensions (Overall): Nominal 75 mm wide x 75 mm high x 75 mm deep.</li> <li>- Basis-of-Design Products: Frost Products Ltd., 1150-SS</li> </ul>
P008	L-Shaped Grab Bar: 38 mm dia. stainless steel, 762 mm x 762 mm, 90 degrees with concealed mounting flanged, satin finish with peened gripping surface, and as follows: <ul style="list-style-type: none"> <li>- Basis-of-Design Products: Bobrick, B-6898.99</li> </ul>
P009	Straight Grab Bar: 38 mm dia. stainless steel, 610 mm long, grab bars with concealed mounting flanges, satin finish with peened gripping surface, and as follows: <ul style="list-style-type: none"> <li>- Basis-of-Design Products: Bobrick, B-6806.99</li> </ul>
P013	Sanitary Napkin Disposal: <ul style="list-style-type: none"> <li>- Finish: Type 304 stainless steel, satin finish.</li> <li>- Capacity: 3/8-L.</li> <li>- Mounting: Surface Mounted.</li> <li>- Basis-of-Design Products: Bobrick, B-270.</li> </ul>

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. This Section specifies the requirements for the supply and installation of all welded, standard metal lockers and required accessories for a complete system.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM A1008/A1008M-23e1, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable
3. Canadian General Standards Board (CGSB):
  1. CAN/CGSB 44.40-2001, Steel Clothing Locker
4. Canadian Standards Association (CSA Group):
  1. CSA/ASC B651:23, Accessible Design for the Built Environment

### **1.4 DEFINITIONS**

1. Base Metal Thickness: Uncoated steel sheet thicknesses indicated as the minimum nominal thickness in this Section and variation permissible under CAN/CGSB 44.40.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

1. Coordination: Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related work specified in other Sections so that metal lockers can be supported and installed as indicated and in accordance with manufacturer's written instructions.

### **1.6 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of metal locker product specified.
  2. Shop Drawings: Submit shop drawings including, but not limited to, type and class of locker, metal thickness, fabrication and assembly methods, accessories, and finishes.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.7 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

### **1.8 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Installer: Authorized representative of metal locker manufacturer for installation and maintenance of units required for this Project.

2. Manufacturer: Obtain metal lockers and accessories through one source from a single manufacturer. Do not modify intended aesthetic appearance of metal lockers without the Consultant's written approval; submit comprehensive explanatory data to Consultant for review where modifications are necessary to meet project requirements before submission of Bids.

### 1.9 DELIVERY, STORAGE AND HANDLING

1. Delivery and Acceptance: Transport metal lockers to site for standard delivery when installation spaces are clean, dry, and ready for metal locker installation.
2. Storage and Handling: Store metal lockers in a clean, safe, dry area, and in accordance with manufacturer's written instructions.

### 1.10 SITE CONDITIONS

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where specified products are indicated to fit together with other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Established Dimensions: Establish dimensions and proceed with fabricating specified products without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for shimming and fitting.

## 2 Products

### 2.1 MANUFACTURERS

1. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. ASI Group Canada.
  2. Hadrian Manufacturing Inc.
  3. Penco Products.
2. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

### 2.2 PERFORMANCE REQUIREMENTS

1. Locker Door-Opening Force: Not exceeding requirements of CSA/ASC 651 for interior swinging doors at 22N.

### 2.3 MATERIALS

1. Cold Rolled Steel Sheet: Commercial Steel (CS) Type B in thicknesses indicated, suitable for exposed applications in accordance with ASTM A1008/A1008M.
2. Fasteners: Zinc or nickel-plated steel, slot less type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.
3. Anchors: Select material, type, size, and finish required for secure anchorage to each substrate, as follows:
  1. Provide nonferrous metal or hot dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
  2. Provide toothed steel expansion sleeves for drilled-in-place anchors.

## 2.4 METAL LOCKERS

1. Metal Lockers: Fabricated in accordance with CAN/CGSB 44.40, and as follows:
  1. Tier Type: Type 2 – Double Tier Lockers.
  2. Class: Class 1 – One complete locker.
  3. Installation: Freestanding.
  4. Size: As indicated on Drawing.
  5. Sheet Steel Size: Minimum 1.6 mm base metal thickness.
  6. Assembly: Knock Down Construction.
  7. Top: Sloped.
  8. Doors: Manufacturer's standard door construction, minimum 0.912 mm thick.
  9. Sound-Dampening Panels: Manufacturer's standard door stiffeners designed to reduce sound levels when doors are closed.
  10. Door Handle and Door Strike: Manufacturer's standard.
  11. Door Style: Non-perforated panel.
  12. Hinges: Manufacturer's standard continuous concealed hinges.
  13. Lock Type: Manufacturer's standard padlock hasp and built-in lock latch.

## 2.5 ACCESSORIES

1. Locker Benches: Fabricated by same manufacturer as metal lockers, and as follows:
  1. Bench Tops: Manufacturer's standard one (1) piece units; minimum 240 mm wide by 32 mm thick having with rounded corners and edges and as follows:
    1. Plastic laminate over medium density particleboard core, with two steel tubes running full length of top and positioned to receive pedestal fasteners; colour: as selected by Consultant from manufacturer's full range.
    2. Freestanding Pedestals: Manufacturer's standard supports having predrilled fastener holes for attaching bench top, fasteners and anchors, and as follows:
      1. Tubular Aluminum: 3 mm thick x 76 mm wide aluminum channel or 6 mm thick trapezoidal or T shaped aluminum bar; non-skid pads at bottom.
      2. Finish: Powder coat finish.
      3. Colour: Match metal lockers.
  2. Coat Hooks. Manufacturer's standard coat hooks.
  3. Hanger Rods: Manufacturer's standard hanger rods.
  4. End Panels: To match metal locker body colour.
  5. Trims: Steel trim to manufacturer's standard including, but not limited to, corner angles, jamb trims, and fillers.
  6. Number Plates: Sequence number to match Owner's standard.

## 2.6 FINISHES

1. Powder coated ed finish to colour selected by Consultant from manufacturer's standard range.

## 3 Execution

### 3.1 EXAMINATION

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

1. Assemble and install lockers in accordance with manufacturer's written instructions level, plumb, and true. Shim as required, using concealed shims.

2. Securely fasten lockers to grounds and nailing strips, and pedestals.
3. Install filler panels (false fronts) where indicated and where obstructions occur.
4. Install finished end back panels to exposed ends and backs of locker banks.
5. Install locker numbers, confirm numbering sequence with Owner and Consultant.
6. Place freestanding locker benches in locations indicated on Drawings.

### **3.3 CLOSEOUT REQUIREMENTS**

1. Adjusting: Lubricate and adjust doors and latches to operate easily without binding.
2. Repairing: Touch up marred finishes or replace metal lockers that cannot be restored to factory finished appearance.
3. Protection:
  1. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint.
  2. Do not permit metal locker use during construction.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section specifies requirements for supply and installation of entrance floor mats and frames as follows:
  1. Frames: Manufacturer's standard frames of size and style for mat type; permanent recessed installation in subfloor having required anchorages and accessories; fabricate frame of same material and finish as mats.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. American Society for Testing and Materials (ASTM International):
  1. ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  2. ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  3. ASTM D2047-17, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine
  4. ASTM E648-23, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
2. Canadian Standards Association (CSA Group):
  1. CSA/ASC B651:23, Accessible Design for the Built Environment
3. Underwriters Laboratories of Canada (ULC):
  1. CAN/ULC S102.2:2018, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies

### **1.4 ADMINISTRATIVE REQUIREMENTS**

1. Coordination:
  1. Coordinate size and location of oversized recesses in concrete work receiving floor mats and frames; delay frame installations until building enclosure is completed and related interior finish work is in progress.
  2. Coordinate top of mat surfaces with bottom of doors swinging across entrance mats and frames, provide information to ensure clearance between mat without impinging operation of door.
  3. Coordinate delivery of entrance mat system with building enclosure to ensure that installation conditions are complete and related interior finish work is in progress.

### **1.5 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including construction details, material descriptions, dimension of individual components and profiles, and finishes for floor mats and frames.
  2. Shop Drawings: Submit shop drawings showing fabrication, assembly, joint locations, installation details, layout, plans, elevations, full scale sections, details of patterns or designs, anchors, and accessories for floor mats and frames.

3. Samples for Verification: Submit 300 mm x 300 mm samples for verification of floor mats and frames with specified finish indicating each type of colour for exposed floor mat, frame and accessories required for verification by Consultant.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

#### **1.7 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant:
  1. Manufacturer: Obtain floor mats and frames from single source by single manufacturer.
  2. Installer: Personnel having two (2) years of experience in similar projects and complexity.

#### **1.8 SITE CONDITIONS**

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where entrance mat systems are indicated to recess in floor assemblies; coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Established Dimensions: Establish dimensions and proceed with fabricating entrance mat systems without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.

#### **1.9 WARRANTY**

1. Manufacturer's Warranty: Provide manufacturer's standard two (2) years warranty against defects in material or workmanship starting from the date of Substantial Performance of the Work.

### **2 Products**

#### **2.1 MANUFACTURERS**

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
  1. Basis-of-Design Products: Construction Specialties (CS), Entrance Flooring, PediTred SA G7.
2. Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Balco, Inc.
  2. K. N. Crowder
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Flammability in accordance with ASTM E648, Class I, Critical Radiant Flux, minimum 0.45 watts/m<sup>2</sup>.
2. Slip Resistance: in accordance with ASTM D2047, Dynamic Coefficient of Friction (DCOF), minimum 0.60 for accessible routes tested in wet conditions.
3. Rolling Load Performance: Using 125 mm Ø x 50 mm wide polyurethane wheel and 270 kg rolling load, no damage after 1000 passes

## 2.3 MATERIALS

1. Extruded Aluminum: Meeting requirements of ASTM B221, alloy 6105 T5 or alloy 6105 T6 as standard with manufacturer; coat surface of frame in contact with cementitious materials with manufacturer's standard protective coating.

## 2.4 ENTRANCE FLOOR MATS AND FRAMES

1. Aluminum Floor Mats: Manufacturer's standard floor mats with extruded members, top surfaced tread rails with following nominal requirements:
  1. Tread Rails: Extruded aluminum tread rails to ASTM B221, alloy 6063-T5, spacing 38 mm O/C.
  2. Level Base Frames: Aluminum, ASTM B221, 6063-T6, nominal 25 mm frame with 6 mm wide exposed surface.
  3. Top Surface: Aluminum, ASTM B221, 6105-T5, 19 mm deep serrated aluminum tread rails joined by flexible TPE combination hinge and cushion.
2. Fasteners, accessories and other materials indicated as provided by the manufacturer on the manufacturer's details and in the manufacturer's installation instructions and required for complete installation to manufacturer's instructions.

## 2.5 FABRICATION

1. Shop fabricate floor mats to greatest extent possible in sizes as indicated; provide each mat as a single unit; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning; space symmetrically and away from normal traffic lanes when joints in mats are necessary.
2. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

## 2.6 FINISHES

1. Colour: Manufacturer's clear anodized finish.

## 3 Execution

### 3.1 EXAMINATION

1. Verification of Conditions: Verify areas and conditions indicated for entrance mats and frames and confirm that conditions detrimental to installation are corrected before starting work of this Section.
2. Installation of products specified in this Section will denote acceptance of site conditions.

### 3.2 INSTALLATION

1. Install floor mats and frames in accordance with manufacturer's written instructions at locations indicated and with top of floor mats and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer.
2. Set floor mat tops at height for most effective cleaning action.

3. Coordinate top of floor mat surfaces with doors that swing across mats to provide clearance under door.

### 3.3 CLOSEOUT ACTIVITIES

1. Demonstration and Training: Demonstrate cleaning methods required to maintain entrance mat and frame system, based on estimated foot traffic requirements for the project.
2. Protection: After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Performance of the Work.

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. This Section specified requirements for supply and installation of vertical wheelchair lifts.

### **1.2 RELATED REQUIREMENTS**

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

### **1.3 REFERENCE STANDARDS**

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing of Materials (ASTM International):
  1. ASTM A36/A36M-19, Standard Specification for Carbon Structural Steel
  2. ASTM A307-21, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
  3. ASTM A666/A666M-24, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
  4. ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
3. American Society of Mechanical Engineers (ASME)/ Canadian Standards Association (CSA Group):
  1. ASME A17.1-2022/CSA B44:22, Safety Code for Elevators and Escalators
4. Canadian Standards Association (CSA Group):
  1. CSA B355:19 (R2024), Platform Lifts and Stair Lifts for Barrier-Free Access
  2. CSA W59:24, Welded Steel Construction

### **1.4 SUBMITTALS**

1. Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data: Submit product data for each type of product specified including construction details, material descriptions, dimensions of individual components, finishes, rated capacities, operating characteristics, electrical characteristics, safety features, controls, and accessories.
  2. Shop drawings: Submit shop drawings for each wheelchair lift including the following:
    1. Plans, elevations, sections, attachment details, and required clearances.
    2. Dimensions, weights, loads, and points of load to building structure.
    3. Details of equipment assemblies, method of field assembly, components, and location and size of each field connection.
    4. Diagrams for power, signal, and control wiring.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.5 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work. Include the following in the maintenance data:
  1. Parts list with sources indicated.

2. Recommended parts inventory lists.
3. Legible schematic wiring diagrams covering electrical equipment as supplied and installed, including changes made in final work, with symbols listed corresponding to identity or markings.
4. Manufacturer's recommended maintenance tasks and frequencies.
5. Owner's Manual detailing the operating, safety, and maintenance procedures of the lift.

## 1.6 QUALITY ASSURANCE

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

## 1.7 WARRANTY

1. Manufacturer's Warranty: Provide manufacturer's standard two (2) years warranty agreeing to repair or replace components of lifts that fail in materials or workmanship starting from the date of Substantial Performance of the Work.

# 2 Products

## 2.1 MANUFACTURERS

1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; manufacturers listed as additional Acceptable Products and that offer similar products may be incorporated into the work of this Section, provided they meet the performance requirements established by the named products.
2. Additional Acceptable Products Manufacturers: Subject to compliance with requirements specified in this Section, use any of the following listed manufacturers' products in accordance with Section 01 62 00 – Product Options provided required product data and shop drawing are submitted before starting any work of this Section:
  1. Garaventa Lift Group, Genesis OPAL - Unenclosed Vertical Platform Lift.
  2. Ram Elevators + Lifts Inc, Commercial Trust Lift.
3. Substitutions: Additional manufacturers offering similar products to Acceptable Products Manufacturers listed above may be incorporated into the work provided they meet the performance requirements established by the named products and provided they submit requests for substitution in accordance with Section 01 25 00 – Substitutions Procedures.

## 2.2 PERFORMANCE REQUIREMENTS

1. Accessibility Standard: Comply with applicable provisions in CSA B355 and Authority Having Jurisdiction.
2. Regulatory Requirements: Comply with ASME A17.1/CSA B44, local codes and regulations.
3. Seismic Requirements: Equipment and components to withstand earthquake forces in accordance with OBC requirements.
4. Welding: To CSA W59.

## 2.3 VERTICAL PLATFORM LIFTS

1. Vertical Platform Lift: Pre-engineered list system as follows:
  1. Number of Stops: As indicated on Drawings.
  2. Platform Size: Nominal 915 mm x 1370 mm clear platform dimensions.
  3. Capacity: Standard 340 kg (750 lbs).
  4. Normal Speed: 0.05 m/s (10 fpm).
  5. Operation: Continuous pressure rocker switch.
  6. Power Supply: 120 VAC single phase, 60 Hz on a dedicated 20-amp circuit.

7. Minimum Pit: Nominal 75 mm.
8. Drive Type: Chain hydraulic.
9. Emergency Operation: Manual device to lower platform and battery auxiliary power to raise or lower platform.
10. Finish: As indicated below in this Section.
11. Platform Configuration:
  1. Straight Through: Front and rear openings.
12. Landing Openings: Self-closing manufacturer standard glass gates, and as follows:
  1. Gate Height: Nominal 1070 mm.
  2. Gate Operation: Low-energy, power operated gates.
13. Self-Supporting Unit: Support vertical loads of unit only at base, with lateral support only at landing levels.
14. Ramp: Manufacturer's standard retractable ramp to suit application or as required.
15. Floor Finish: Anti-skid selected by Consultant from manufacturer's standard range.
16. Basis-of-Design Products: Savaria, V-1504.

## **2.4 SIGNAGE**

1. Provide lift with all necessary signs, capacity plates, and data signs complying with the Local and National Codes and Standards.
2. A capacity plate indicating the rated load in pounds and kilograms and operating instructions shall be furnished by the manufacturer and fastened in a conspicuous place at each landing and in the platform. The capacity plate and operating instructions will be engraved on non-glare, micro-surface, white letters on a blue background, self-adhesive, flexible plastic material. The letters and figures stating the capacity shall not be less than 6 mm in height.

## **2.5 BILINGUAL MARKINGS (WHERE REQUIRED)**

1. Engrave identification and instructions at least 0.25 mm deep on operating panels and on signal equipment in both English and French except where design is such that inference is obvious and readily understood. Submit to Consultant markings and designs for approval.

## **2.6 FINISH**

1. Electrostatically applied baked polyester powder coating paint finish. Colour as selected by Consultant from manufacturer's standard range.

# **3 Execution**

## **3.1 EXAMINATION**

1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, critical dimensions, and other conditions affecting performance of the Work.
2. Minimum Headroom Clearance: Verify that installed lift will have a minimum headroom at any point during travel.
3. Prepare written report, endorsed by installer, listing conditions detrimental to performance.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

## **3.2 PREPARATION**

1. Re-inspect the construction and service requirements for Work by trades related to, but not described in this specification section. These requirements will be included in drawings, diagrams, engineering data sheets and special instructions before the work commences.

### 3.3 INSTALLATION

1. Install in accordance with manufacturer's instructions and ASME A17.1/CSA B44 unless otherwise noted.
2. Secure lifts to building construction as follows unless otherwise indicated:
  1. For steel-framed partitions, use hanger or lag bolts set into metal backing between studs. Coordinate with stud installation to locate backing members.
3. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces. Bundle, lace, and route conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
4. Coordinate runway doors with platform travel and positioning, for accurate alignment and minimum clearance between platforms, runway doors, sills, and door frames.
5. Position sills accurately and fill space under sills solidly with non-shrink, non-metallic grout.
6. Coordinate platform doors with platform travel and positioning.
7. Adjust stops for accurate stopping and leveling at each landing, within required tolerances.
  1. Leveling Tolerance: 6 mm up or down, regardless of load and direction of travel.
8. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.
9. Test safety devices and verify smoothness of required protective enclosures and other surfaces.

### 3.4 SITE QUALITY CONTROL

1. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and Authorities Having Jurisdiction.
2. Operating Test: In addition to acceptance testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.
3. Advise Owner, Consultant, and Authorities Having Jurisdiction in advance of dates and times tests are to be performed on lifts.

### 3.5 MAINTENANCE SERVICE

1. Initial Maintenance Service: Beginning at Substantial Performance, maintenance service shall include twelve (12) months' full maintenance by skilled employees of lift Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

### 3.6 CLOSEOUT ACTIVITIES

1. Adjusting:
  1. Adjust floor levelling feature at each floor.
  2. Design and adjust equipment to achieve smooth acceleration and deceleration of lift without perceptible steps so adjusted as not to cause passenger discomfort.
  3. Touch-Up:
    1. Upon completion, touch-up and restore to new condition, damaged or defaced factory finished surfaces.

2. Remove protective coverings and clean exposed surfaces after completion and leave in first class condition.

2. Cleaning:

1. Remove protective coverings from finished surfaces and components.
2. Clean surfaces and components ready for inspection.
3. Touch up and restore to new condition, damaged or defaced factory finished surfaces.
4. Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 23 – Final Cleaning.

3. Demonstration and Training:

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.
2. Check operation of lifts with Owner's personnel present and before date of Substantial Performance. Determine that operating systems and devices are functioning properly.
3. Check operation of lifts with Owner's personnel present not more than one month before end of warranty period. Determine that operating systems and devices are functioning properly.

**END OF SECTION**

## **1 General**

### **1.1 REFERENCES**

1. Conform to Division 1, General Requirements

### **1.2 CODES, STANDARDS AND LAWS**

1. All work shall be carried out in accordance with the applicable regulations of the following authoritative bodies, codes in effect at the time of Tender, and any other Authority having jurisdiction:
  1. Ontario Building Code
  2. Ontario Plumbing Code
  3. Ontario Fire Code
  4. Fire Marshall
  5. Worker's Compensation Board
  6. Local Building By-Laws
  7. Canadian Safety Standard (CSA Group):
    1. CSA B149.1, Natural Gas and Propane Installation Code
    2. CSA B51, Boiler, Pressure Vessel, And Pressure Piping Code
    3. CSA B52, Mechanical Refrigeration Code.
    4. CAN/CSA C22.2.CAN/CSA C747, Energy Efficiency Test Methods for Small Motors.
    5. CAN/CSA C390, Test methods, marking requirements and energy efficiency levels for three-phase induction motors.
  8. Electrical Equipment Manufacturers' Association Council (EEMAC)
  9. Institute of Electrical and Electronic Engineers (IEEE)
    1. IEEE 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
  10. National Electrical Manufacturers' Association (NEMA)
2. National Fire Protection Association (NFPA):
  1. NFPA 13, Installation of Sprinkler Systems

### **1.3 WORK STANDARDS**

1. All Codes and Standards referred to in this Section are the latest edition of the Codes and Standards in effect at the time of tendering this Contract.
2. All mechanical piping system Work, including equipment, must comply in all respects with requirements of the Ontario Technical Standards and Safety Authority, and CSA Standards B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, fittings, valves, equipment, etc., must bear a CRN number.
3. All electrical items associated with mechanical equipment shall be CSA (or equivalent agency certified electrically) or bear a stamp to indicate special Electrical Safety Authority approval.

### **1.4 DEFINITIONS**

1. The following are definitions of words found in Sections of Divisions 20, 22, 23 and 25 and on associated Drawings:
  1. "Concealed" – means Work hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
  2. "Exposed" – means Work normally visible, including Work in equipment rooms and similar spaces.
  3. "Provide" (and tenses of "provide") – means supply and install complete.

4. "Install" (and tenses of "install") – means install and connect complete.
5. "Supply" – means supply only.
6. "Finished area" - means any area or part of an area which receives a finish such as paint, or is factory finished.
2. Wherever the words "indicated", "shown", "noted", "listed", or similar words or phrases are used in the Specification Sections they are understood, unless otherwise defined in the Contract Documents, to mean that the product referred to is "indicated", "shown", "listed", or "noted" on the Drawings.
3. Wherever the words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected" or similar words or phrases are used in the Specification Sections they are understood, unless otherwise defined in the Contract Documents, to mean that Work or product referred to is "approved by", "inspected by", etc., the Consultant.

#### **1.5 WORKPLACE SAFETY**

1. Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding the use, handling, storage and disposal of hazardous materials.
2. Comply with all requirements of O.Reg 213/91, Construction Projects, enacted under the Occupational Health and Safety Act.

#### **1.6 APPLICATION**

1. This Section specifies requirements, products, common criteria and characteristics, and methods and execution that are common to one or more Sections of Divisions 20, 22, 23 and 25, and it is intended as a supplement to each Section and shall be read accordingly

#### **1.7 PLANNING AND LAYOUT OF WORK**

1. The exact locations and routing of mechanical and electrical services shall be properly planned, coordinated and established with all affected trades prior to installation such that the services will clear each other as well as any obstructions. Generally, give the right-of-way to piping requiring uniform pitch and locate and arrange other services to suit.
2. All shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings or in walls, must be located for easy access for servicing and/or removal. Products which do not meet the location's requirements shall be relocated at no cost to the Owner.
3. Provide hangers, anchors, thermal expansion/ contraction, and pipe alignment guides on all piping systems throughout the project. Submit expansion/ contraction layout, calculations with all equipment/ contraction devices.
4. Provide multi-directional expansion/ contraction pipe loops and ductwork flexible connection at all building expansion joints.

#### **1.8 DOCUMENTS**

1. The Contract Drawings are performance Drawings, which are diagrammatical, and show approximate locations for equipment and materials. The Drawings are intended to convey the scope of work and do not necessarily show all architectural and structural details. The Contractor is responsible for communicating and coordinating the final details off all work with the trades. The locations of materials and equipment shown may be altered (when revised layouts have been submitted and approved), to meet requirements of the material and/or equipment, other equipment and systems being installed, and of the building. Provide all fittings, offsets, transformations, and similar items required as a result of obstructions and other architectural or structural details but not shown on the Mechanical Drawings.

### 1.9 ACCEPTABLE PRODUCT MANUFACTURERS

1. Products scheduled and/or specified on the Drawings and in the Sections of Divisions 22 and 23 have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, acceptable manufacturers are stated for any product specified by manufacturer's name and model number. The Contract price may be based on products supplied by any of the manufacturers named as acceptable for the particular product. If acceptable manufacturers are not stated for a particular product, base the Contract price on the products supplied by the specified manufacturers.
2. If products supplied by a manufacturer are listed as "equivalent" or an "acceptable alternative" in any Section of Divisions 20, 21, 22, 23 and 25 are used in lieu of the specified manufacturer, the Contractor shall be responsible for ensuring that the substituted product is equivalent in performance and operating characteristics (including energy consumption or noise levels if applicable) to the specified product, and, it is to be understood that any additional costs, and changes to associated or adjacent Work resulting from provision of products supplied by a manufacturer other than the specified manufacturer is included in the Contract price. In addition, in locations where products named as "equivalent" or "acceptable alternative" are used in lieu of specified products and the dimensions of such products differ from the specified products, prepare and submit for review, accurately dimensioned layouts of rooms affected.

### 1.10 SUBMITTALS

1. Submit the following for review:
  1. Shop drawings for all products specified in this Section.
  2. Sleeve and formed opening location drawings:
    1. Prepare and submit for review and forwarding to the concrete reinforcement detailer, drawings indicating all required sleeves, recesses and formed openings in poured concrete work. Such drawings shall be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum.
    2. Begin to prepare such drawings immediately upon notification of acceptance of Tender and award of Contract.
  3. Samples of materials and any other items as specified in other Sections of this Division.
  4. WHMIS MSDS – Material Safety Data Sheets for all products where required, and maintain one copy at the site in a visible and accessible location and available to all personnel.
  5. A list of equipment identification nameplates indicating proposed wording and sizes.
  6. A list of pipe and duct identification colour coding and wording.
  7. A proposed valve tag chart and a list of proposed valve tag numbering and identification wording.
  8. A clean "reviewed" copy of each shop drawing for insertion into the O&M instruction manual.

### 1.11 SHOP DRAWINGS

1. The following shall be read in conjunction with the wording on the Consultant's shop drawing review stamp applied to each and every mechanical work shop drawing submitted:



1. "This review is for the sole purpose of ascertaining conformance with the general design concept. This review does not approve the detail design inherent in the shop drawings, responsibility for which remains with the Contractor, and such review does not relieve the Contractor of its responsibility for errors or omissions in the shop drawings or of its responsibility for meeting all requirements of the Contract Documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all sub-trades/subcontractors."

#### **1.12 OPERATING AND MAINTENANCE INSTRUCTION MANUALS**

1. The Contractor will prepare and submit for review to the Consultant one (1) copy of:
  1. Permits, inspection certificates, and the like,
  2. Shop drawings for all mechanical equipment,
  3. Pipe leakage test sheets, manufacturer's startup check sheets, and similar data,
  4. All required operating and maintenance instruction data,
  5. Valve tag charts,
  6. All other data specified in applicable Sections of Divisions 20, 22, 23 and 25 of the Specification.
2. Each manual is to be organized into the following categories:
  1. A - Project Directory
  2. B - Warranty Letter
  3. C - All applicable certifications letters
  4. D - Plumbing and Drainage
  5. F - Heating
  6. G - Air Handling Units
  7. H - Ventilation and Noise Attenuation
  8. I - Chilled Water
  9. J - Building Management System
3. The project directory is to contain the names, addresses, telephone and fax numbers of the Project Team, including:
  1. Owner,
  2. Architect,
  3. Mechanical Consultant,
  4. General Contractor,
  5. Mechanical Sub-contractors,
  6. Manufacturers and manufacturer's representatives.
4. Sections D to I are to be divided into the following subsections:
  1. Shop Drawings
  2. Operation Procedures
  3. Maintenance Procedures
  4. Spare Parts List
  5. Trouble Shooting Guide
  6. Valve Chart (where applicable)
  7. Filter Size Chart (where applicable)
  8. Equipment Lists
  9. Testing and Verification Forms
  10. Certification Forms (start up??)
5. Section J is to be divided into subsections as follows:
  1. Shop Drawings
  2. As-Built Control Sequences

3. As-Built Panel Layout and Points List
  4. All Point Log Per System
  5. Operating Procedures for all Equipment and Systems
  6. Maintenance Procedures for all Equipment
  7. Spare Parts List
  8. Software Licensing Agreements
  9. Software Manuals
  10. Software Disks
  11. Point Data and Program Disks
  12. Testing and Verification Forms
6. The operating procedures are to be the manufacturer's recommended operating procedures for the equipment.
  7. The maintenance procedures are to include Scope of Work, frequency of activity, parts required, and necessary documentation.
  8. The spare parts list is to be the manufacturer's recommended list for maintenance purposes.
  9. The trouble shooting guide is to be the manufacturer's recommendations for the equipment.
  10. The equipment list is to include make, model, serial number, electrical characteristics, RPM, pump impeller sizes, fan belt and sheave sizes, as applicable.

#### **1.13 AS-BUILT DOCUMENTATION**

1. Submit as-built drawings identifying final location of all pipes, ducts, dampers, valves, access doors, and actual room names or numbers.
2. This Contractor shall be responsible for and keeping an up to date set of As-Built drawings at the jobsite office.
3. The As-Built drawings shall be maintained in constant up-to-date condition by each trade.
4. The As-Built drawings shall include, but not be limited to, the following changes and shall be recorded daily:
  1. Size, location, arrangement, route and extent of ductwork, piping, conduit, terminal units, equipment, fixtures, cleanouts, valves, rough-in, etc.
5. Piping Elevations:
  1. Water Lines: All water lines. Invert elevations to be given at each junction, changes of direction horizontally and vertically and at every 30 m run as well as type of material used.
  2. Sanitary sewers and Storm sewers.
  3. Heating, Chilled water and Plumbing Lines: All piping of any size. Invert elevations to be given at each junction, at change of direction, at high and low points.
  4. Ductwork: All ductwork. Bottom of duct elevations to be given at each junction, change of direction, and at high/ low points.
6. All valve stations, trap stations, coils, dampers and ductwork not easily accessible.
7. All changes which affect the operation of the mechanical system.
8. At end of construction, the final As-Built drawings shall be translated to Revit or AutoCAD (use the same software as the Consultant) and a final set of PDFs shall be made available to the Owner and Consultant for review.
9. Location, tagging and numbering of all valves except individual plumbing fixtures or equipment isolation valves.

10. The as-built daily marked-up prints shall conform to the standards of the contract drawings and shall include all details from revision drawings, supplementary drawings, change orders, addenda and site revisions, etc. Provide controls as built drawings from controls contractor. Each white print drawing sheet shall be marked: "We hereby certify that these drawings represent the building, as built." with signatures immediately below of authorized personnel of the Contractor

#### **1.14 EQUIPMENT AND SYSTEM STARTUP AND COMMISSIONING**

1. An independent Commissioning Agent ("Commissioning Agent") shall be retained by the Contractor to supervise the system and equipment startup and performance testing, to test and balance air and water flows, to make final adjustments to equipment and systems, to prepare operating and maintenance instruction manuals, to update CADD discs for record drawings, and to provide other associated services.
2. The work for the independent Commissioning Agent is specified in Section 01 91 00 – Commissioning – Mechanical and Electrical. Carefully read Section 01 91 00 and provide for all labour to physically perform start-ups and performance testing, supply of equipment manufacturer's representatives and technicians on-site, services, etc., which are indicated as being supplied by the Contractor, including:
  1. Data and shop drawings for operation and maintenance manuals.
  2. Marked-up white print "record drawings" prepared on site during construction.
  3. All test data and certificates.
3. The majority of the Commissioning Work specified in Section 01 91 00 must be complete prior to application for Substantial Performance of the Work.

## **2 Products**

### **PIPE SLEEVES**

1. Minimum 1.6 mm thick (16 ga) galvanized steel with an integral flange at one end to secure the sleeve to formwork construction.
2. Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
3. Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at the sleeve midpoint.

### **2.2 FIRESTOPPING AND SMOKE SEAL MATERIALS**

1. Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN4-S115 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 the fire resistance rating of surrounding construction.
2. Pipe insulation forming part of a ULC fire and smoke seal assembly is specified in Section 20 07 00.

### **2.3 WATERPROOFING SEAL MATERIALS**

1. Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so that when the bolts are tightened the links expand to seal the opening watertight. The seal assemblies shall be selected to suit the pipe size and the sleeve size or wall opening size. Acceptable products are:
  1. Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S.
  2. The Metraflex Co. "MetraSeal" type ES.

## **2.4 PIPE ESCUTCHEON PLATES**

1. One-piece chrome plated brass or #4 finish type 302 stainless steel plates with screws, each sized to cover the pipe sleeve or wall or slab opening, and to fit tightly around the pipe or pipe insulation.

## **2.5 FLASHINGS AND COUNTER FLASHINGS**

1. Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.
2. Stainless steel flashing sleeve, integral deck flange and EPDM seal.

## **2.6 EQUIPMENT DRIVE GUARDS AND ACCESSORIES**

1. For V-belt drives - removable, four sided, fully enclosed, galvanized sheet steel guards to OSHA standards, complete with 115 mm (4.5") diameter tachometer openings covered with removable perforated galvanized plates at each shaft location.
2. For flexible couplings - removable "U" shaped galvanized steel guards with a 2.3 mm (0.093") thick frame and expanded mesh face.
3. For exposed fan blades, unless otherwise specified in the Contract Documents - removable 12 mm (0.5") galvanized steel wire mesh with galvanized steel frames.

## **2.7 COMMON ELECTRICAL REQUIREMENTS**

1. Division 26 – Electrical, shall provide all line side power wiring for equipment and control devices provided by Division 20 – Mechanical, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – HVAC, and Division 25 – Integrated Automation.
2. Load side power wiring of control devices to motors shall be under Division 26. Divisions 20, 21, 22, 23, and 25 shall provide all local disconnect switches, control panels, starters, and VFD's for mechanical equipment as required.
3. Control wiring of local safeties and interlocks for packaged equipment shall be provided under the respective Sections unless otherwise specified in the Contract Documents.
4. Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical. Starters to be in strict accordance with Division 26 – Electrical.
5. Check all wiring diagrams and control diagrams submitted in shop drawing form. Before submitting these shop drawings to the Consultant, submit these drawings to Division 26 - Electrical Contractor for approval. Have these drawings stamped by Division 26 - Electrical Contractor as verification of their approval before forwarding to the Consultant. Co-operate in the commissioning of all electrically driven equipment with Division 26 - Electrical.

## **2.8 COMMON MOTORS REQUIREMENTS**

1. General:
  1. The efficiency of single phase motors to 0.746 kW (1 HP) is to be in accordance with CAN/CSA – C747. The efficiency of all three phase motors 0.746 kW (1 HP) and larger shall be equal to or exceed the NEMA Premium Efficiency designation as tested in accordance with CSA C390 or IEEE 112.
2. Motors:
  1. Unless otherwise specified in the Contract Documents, motors shall conform to EEMAC Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards.
  2. Vertically mounted and submersible motors shall be purposely designed for mounting in this attitude.

3. Single Phase Motors: Unless otherwise specified in the Contract Documents, motors smaller than 0.373 kW (0.5 HP) shall be 115 volt, continuous duty capacitor start type with an EEMAC 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 (104°F) ambient temperature.
4. Three Phase Motors: Unless otherwise specified in the Contract Documents, motors 0.373 kW (0.5 HP) and larger shall be totally enclosed, fan cooled (TEFC), 3 phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on the Drawings, NEMA Premium designs, EEMAC Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "F" insulation or better with Class "B" temperature rise, a 1.5 service factor at 40°C (104°F) ambient temperature, windings dipped and baked a minimum of two times in a Class "H" varnish up to frame 256T and three times on larger frame sizes. All motor windings shall be suitable for use on VFD. Regreasable (on frames 284T and above), open or shielded ball or roller bearings with grease fittings to permit relubrication without dismantling the motor and while in operation, bearings shall have an L10 life of 40,000 hours on belt drive service and 100,000 hours on direct coupled service in accordance with AFBMA, a cast iron frame (Grade 25 or better) with cast iron feet where required, cast iron end bracket and precision machined bearing fits, and precision balanced carbon steel shaft assembly with die-cast aluminum rotor windings, two breather holes shall be provided at the lowest points in the motor frame or bracket, shaft slingers on DE shaft, lifting bolts required on frames 182T and above. Conduit box volume shall be one size larger than NEMA standard. Zinc-dichromate plated hardware shall be provided on all motors.
5. Thermistor Protection: Motors 22.37 kW (30 HP) and larger, as scheduled in the Contract Drawings, shall be complete with a heat sensing Siemens PTC thermistor (or an approved equivalent) in the end turn of the stator winding for each phase and connected in series inside the motor with two marked leads brought out to the main motor conduit box.
6. Motors for VFD's: Motors for equipment with variable frequency drives shall be inverter duty, quantified by CSA for operation from a variable frequency drive of the type specified in the Contract Documents. Motors on VFD service above 150 kW (200 HP) shall be provided with insulated bearings to mitigate any electrical discharge machining (EDM) issues due to the discharge of VFD induced shaft voltage. Motors shall be provided with shaft grounding devices to create a path from the motor shaft to ground to allow discharge of VFD induced shaft voltage.
7. Acceptable Manufacturers:
  1. TECO-Westinghouse Motors (Canada) Inc.
  2. GE Canada Inc.
  3. Baldor Electric Company
  4. U.S. Motors (Nidec Motor Corporation)
  5. Emerson Electric Company
  6. Weg Canada Ltd.
  7. Marathon Electric Corporation
  8. Leeson Electric Corporation
  9. Toshiba International Corporation
  10. Brook Crompton (Canada) Inc.
3. Drive Guards and Accessories:
  1. For V-belt drives - removable, four sided, fully enclosed, galvanized sheet steel guards in accordance with OSHA standards, complete with 115 mm (4.5") diameter tachometer openings covered with removable perforated galvanized plates at each shaft location.

2. For flexible couplings - removable "U" shaped galvanized steel guards with a 2.3 mm (0.093") thick frame and expanded mesh face.
3. For exposed fan blades, unless otherwise specified in the Contract Documents, removable 12 mm (0.5") galvanized steel wire mesh with galvanized steel frames.

## 2.9 BEDDING/BACKFILL MATERIALS

1. To the requirements for Granulars "A", "B" (Type 1), "M" and "Select Subgrade Material"; Ontario Provincial Standard Specifications (OPSS), Form No. 1010 for Granulars "A", "B", "M" and "Select Subgrade" material.
2. Requirements for Pea Gravel: Granular, well-graded clean rounded pea gravel or stone with not more the 2% material that will pass 75 um (No. 200) sieve, maximum 6 mm (¼ in.), containing not other deleterious material, and subject to testing that specified density can be achieved without compaction.
3. Requirements for Sand Fill: Uniform quality and unwashed river sand or any clean sand containing less than 5% organic materials, clay or silt (passing 125 um sieve) is acceptable. It can contain a limited amount of small stones or rocks as it comes from the pit. Sharp, clean, coarse sand, water washed, free from clay, salts and organic matter, and in accordance with CSA A179-93 for masonry sand is also acceptable.

## 3 Execution

### 3.1 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 in the Contract Documents: minimum 1.6 mm thick (16 ga) flanged galvanized steel or, where permitted by governing authorities, factory fabricated, high density polyethylene sleeves.
  2. In concrete or masonry walls: Schedule 40 galvanized steel pipe.
2. Sleeves in waterproofed slabs shall be lengths of Schedule 40 mild galvanized steel pipe in accordance with the Drawing detail. Provide waterproof sleeves in the 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 all floors equipped with waterproof membranes.
  4. In the roof.
3. Size sleeves, unless otherwise specified in the Contract Documents, to leave 12 mm (½") clearance around the pipes, or where pipe is insulated, a 12 mm (½") clearance around the pipe insulation.
4. Where piping passes below strip footings, provide minimum clearance of 2" (50mm) between sleeve and pipe. Backfill up to underside of footing with concrete of same strength as footing.
5. For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction, caulk between sleeve recess and pipe, fasten roof flashing to clamp device, make water-tight durable joint. Co-ordinate with roofing Section.
  1. Pack and seal the void between the pipe sleeves and the pipe or pipe insulation for the length of the sleeves as follows:
  2. Pack sleeves in fire rated construction as specified in the article entitled "INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS".
  3. Pack sleeves in non-fire rated interior construction with mineral wool and seal both ends of the sleeves with non-hardening silicone base caulking compound.

4. Pack sleeves in exterior walls above grade with mineral wool and seal both ends of the sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified in the Contract Documents.
5. Seal sleeves in exterior walls (and any other wall where water leakage may be a problem) with link type mechanical seals.
6. Sleeves in fire rated construction will be packed and sealed as part of the work of Division 7.
6. Where sleeves are required in masonry work, accurately locate and mark the sleeve position, and turn the sleeves over to the trade performing the masonry work for installation.
7. Terminate sleeves for piping which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors.
8. Sleeve through waterproof floor:
  1. Extend sleeve 100 mm (4") above the finished surface.
  2. Provide watertight concrete curb 4" (100mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100mm) clearance between openings for services within curbs.
9. "Gang" type sleeving will not be permitted.
10. Where sleeves are provided for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of the sleeved opening.

### **3.2 INSTALLATION OF WATERPROOFING SEAL MATERIALS**

1. Provide watertight link type mechanical seals in exterior wall openings where shown and/or specified on the Drawings.
2. Assemble and install each mechanical seal in accordance with the manufacturer's instructions.
3. Periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until the seal is completely watertight.

### **3.3 INSTALLATION OF PIPE ESCUTCHEON PLATES**

1. Provide escutcheon plates suitable secured over all 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 the plates so that they are tight against the building surface concerned, and ensure that the plates completely cover pipe sleeves and/or openings, except where waterproof sleeves extend above floors.

### **3.4 INSTALLATION OF FLASHINGS**

1. Provide all flashing at each point where piping passes through the roof.
2. Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

### **3.5 DUCT OPENINGS**

1. Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in poured concrete work, masonry, drywall and other building surfaces by the trade responsible for the particular construction in which the opening is required.
2. Ensure that openings for fire dampers to 600 mm (24") high are sized to suit the damper arrangement with the folding blade out of the air stream.

### **3.6 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIAL**

1. Where mechanical Work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal material installed in accordance with the ULC Firestop System requirements to seal holes and voids in the walls or slabs, as follows:
  1. Bare pipe or conduit through a floor with a circular sleeved or core drilled opening - ULC System SP115.
  2. Bare pipe or conduit through a floor with a rectangular cast or cut opening - ULC System SP116.
  3. Bare pipe or conduit through a wall with a circular sleeved or core drilled opening - ULC System SP114.
  4. Bare pipe or conduit through a wall with a rectangular cast or cut opening - ULC System SP107.
  5. Insulated pipe through a wall with a sleeved or core drilled circular opening - ULC System SP108.
  6. Insulated pipe through a wall with a rectangular cast or cut opening - ULC System SP107.
  7. Insulated pipe through a floor with a circular sleeved or core drilled opening - ULC System SP109.
  8. Insulated pipe through a floor with a rectangular cast or cut opening - ULC System SP116.
2. Note that the insulation for insulated piping penetrating fire-rated construction is specified in Section 23 07 00 and is fire-rated insulation with a vapour barrier jacket, ULC listed as a firestop component for use with ULC Systems SP107, SP108, SP109, and SP116.
3. At all fusible link damper locations in ductwork penetrating fire rated construction, seal the perimeter of the angle iron framing on both sides of the wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal.
4. Provide Engineering Judgments for all pipe penetrations that do not match the ULC system requirements, due to differences including but not limited to insulation thickness, pipe diameter, etc.

### **3.7 INSTALLATION OF FASTENING AND SECURING HARDWARE**

1. Provide all fastening and securing hardware required for mechanical Work to maintain installations attached to the structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.
2. Use fasteners compatible with the 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 the floor, wall or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure proper securement to the structure that is to support the products. Provide reinforcing or connecting supports where required to distribute the loading to the structural components.
4. Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with the requirements of CSA Standards CAN3-Z166.1 and 2-M85.

### **3.8 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES**

1. Protect all exposed accessible rotating parts on all mechanical equipment with a guard.
2. Secure guards to the equipment or equipment base but do not bridge sound or vibration isolation.



### **3.9 INTERRUPTIONS TO AND SHUT-DOWNS OF MECHANICAL SERVICES AND SYSTEMS**

1. Co-ordinate all shut-downs and interruptions to the existing systems. Generally, shut-downs may be performed only between the hours of 12:00 midnight Sunday until 6:00 a.m. Monday morning.
2. Upon award of the contract, submit a list of anticipated shut-down times and their maximum duration.
3. Prior to each shut-down or interruption, inform the Owner in writing 72 hours in advance of the proposed shut-down or interruption and obtain written approval from the Owner to proceed. Do not shut-down or interrupt any system or service without such written approval.
4. Perform work associated with shut-downs and interruptions as continuous operations to minimize the shut-down time and to reinstate the systems as soon as possible. Prior to any shut-down, ensure that all materials and labour required to complete the work for which the shut-down is required are available at the site.

### **3.10 EQUIPMENT BASES AND SUPPORT**

1. Unless otherwise specified in the Contract Documents, set all floor mounted equipment on 100 mm (4") high concrete housekeeping pads, 100 mm (4") wider and longer than the equipment base dimensions.
2. Supply dimensioned drawings, equipment base templates and anchor bolts for proper setting and securing of equipment on pads, and be responsible for all required leveling, alignment, and grouting of the equipment.
3. For equipment not designed for base mounting, where required, provide prime coat painted structural steel stands flange bolted to housekeeping pads.
4. Provide prime coat painted structural black steel angle or channel frames and brackets for all surface wall mounted equipment not specifically designed for surface wall mounting, unless otherwise specified in the Contract Documents.

### **3.11 EXCAVATION AND BACKFILL WORK**

1. Excavation, backfill and related Work such as dewatering required for the mechanical Work will be performed as part of the Work of Division 31, except for final hand grading Work which is to be performed as part of the Work of Division 20, 21, 22, 23, and 25.
2. Inverts and locations of existing site services have been shown on the Drawings. The inverts and locations shown are approximate, and it is your responsibility to confirm and satisfy yourself that the inverts and locations as shown are correct, prior to commencing site service Work.
3. Accurately mark-out the location and routing of excavation required for the work of this Section, as well as the required depth.
4. Ensure that all underground piping subject to freezing and located outside the building has a minimum of 1.5 m of cover.
5. Ensure that all underground piping subject to freezing and located inside the building in unheated areas has a minimum of 450 mm of cover.
6. Ensure that pipe bedding is proper prior to laying pipes. Hand excavate under pipe hubs, couplings, flanges and similar items to ensure even bearing along the entire barrel of each length of pipe.
7. Ensure that piping is inspected, leakage tested and approved prior to backfilling. Supervise the initial backfilling operation to ensure that the buried Work is not disturbed.
8. Protection: Provide protection to existing structures and services. Be responsible for rectifying any damage to existing structures and services resulting from this operation.

9. Excavation in Soil:
  1. Where rough excavation is carried out by Division 31, perform all layout work for trenches required under this Division, including verification of trench depths and slopes. Work in close cooperation with excavating trades that remove subgrade to within 6 in. (150 mm) of the correct and final trench depth
  2. Perform the final excavation to the correct trench invert to permit proper bedding. Excavation carried below the correct inverts shall be backfilled with 2000 psi (13.5 mPa) concrete to the underside of the pipe lines, unless otherwise directed in writing.
10. Ensure that piping is inspected, leakage tested and approved prior to backfilling. Supervise the initial backfilling operation to ensure that the buried Work is not disturbed.
11. Backfill pipe trenches with sand to a depth 300 mm (12 in.) above the pipe. The sand shall be thoroughly tamped around and over the pipes in 150 mm (6 in.) layers.
12. Ensure that all piping under the building footing is protected and encased in concrete and within an additional protective sleeve. Refer to structural for concrete encased piping details.

### **3.12 PACKING AND SEALING CORE DRILLED PIPE OPENINGS**

1. Pack and seal the void between the pipe opening and the pipe or pipe insulation for the length of the opening as follows:
  1. Pack openings in non-fire rated interior construction with mineral wool and seal both ends of the opening with non-hardening silicone base caulking compound to produce a water-tight seal.
  2. Pack and seal openings in fire rated walls and slabs as specified in this Section.
  3. Pack and seal openings in exterior walls with mechanical link type waterproofing seal materials specified in PART 2 of this Section.

### **3.13 HOISTS AND SCAFFOLDS**

1. Provide interior movable or roller scaffolds for the installation of the mechanical work.

### **3.14 ACCESS OF EQUIPMENT**

1. Make all arrangements to ensure that access into the building is available for all mechanical equipment. Do all hoisting and rigging into place of all specified equipment and be responsible for any damages incurred.

### **3.15 EQUIPMENT PROTECTION AND CLEAN-UP**

1. Protect equipment and material in storage on site and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
2. Protect equipment with polyethylene covers and crates.
3. Operate, drain and flush out bearings and refill with new change of oil, before final acceptance.
4. Thoroughly clean piping, ducts and equipment of dirt, cuttings, and other foreign material.
5. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
6. Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

### **3.16 TEMPORARY OR TRIAL USAGE**

1. Temporary or trial usage by the Owner of mechanical equipment supplied under contract shall not represent acceptance.
2. Repair or replace permanent equipment used temporarily.

3. Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

### **3.17 SEMI-FINAL AND FINAL INSPECTIONS**

1. Perform the following items prior to semi-final inspection:
2. Make heating and air conditioning systems capable of operation with automatic controls in operation generally, but not necessarily finally calibrated.
3. Make necessary tests on equipment including those required by authorities having jurisdiction. Obtain certificates of approval.
4. Rough balance air systems.
5. Completely identify equipment so as to be clearly visible.
6. Lubricate equipment as per manufacturer's data.
7. Mail warranty forms to manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.
8. Submit sample of Operating/Maintenance Manuals. Arrange Operating and Maintenance Instructions and submit schedule for approval.
9. Review and ensure access doors are suitably located and of correct type and equipment is easily accessible including plumbing cleanouts.
10. Clean fan plenums, remove temporary filters and install permanent filters.
11. Check operations of plumbing systems and fixtures, and ensure fixtures are solidly supported.
12. Prior to semi-final inspection, provide complete list of items which are deficient at the time of the semi-final inspection.
13. Provide declaration in writing that deficiencies noted at time of semi-final inspection have been corrected and the following items completed prior to the final inspection:
14. Clean equipment both inside and out and lubricate.
15. Clean plumbing fixtures and brass.
16. Complete final balancing.
17. Submit rough data of balance reports.
18. Complete final calibration.

### **3.18 SUBSTANTIAL COMPLETION INSPECTION**

1. Prior to the Contractor requesting an inspection for substantial completion all the following items must be provided to permit beneficial use by the Owner.
  1. Maintenance and Operating Manuals to be submitted and approved.
  2. As-Built drawings.
  3. Air balancing reports.
  4. All motor name plate ratings and actual operating amps and voltages.
  5. All systems shall be certified in writing by the Contractor as complete and fully operational.
  6. Instructions to the Owner's operating personnel shall be provided in accordance with the specifications. A signed statement to this effect, countersigned by the Owner, shall be submitted to the Architect.
  7. A complete list of items which the Contractor has not finished or are deficient shall be provided. If, in the opinion of the Engineer, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.

8. The Contractor shall be fully responsible to accumulate all necessary data from this Sub-trades and suppliers and present same in the specified format for the approval by the Engineer.

### 3.19 INSTRUCTIONS TO OWNER

1. Instruct the Owner's designated representatives in all aspects of the operation and maintenance of systems and equipment specified in this Division.
2. Arrange and pay for the services at the site of qualified technicians and other manufacturer's representatives to instruct on specialized portions of the installation.
3. Submit, prior to issue of a Certificate of Substantial Performance, a complete list of systems for which instructions were given to the Owner, stating for each system:
  1. Date instructions were given to the Owner's staff;
  2. Duration of instruction;
  3. Names of persons instructed;
  4. Other parties present (manufacturer's representatives, etc.).
4. Obtain the signatures of the Owner's staff to verify that they properly understood the system installation, operation and maintenance requirements and have received operating and maintenance manuals and record Drawings.

### 3.20 COMMON MOTOR REQUIREMENTS

1. Manufacturer's Instructions:
  1. Compliance: comply with Manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
2. Installation of Equipment Drive Guards and Accessories:
  1. Protect all exposed accessible rotating parts on all mechanical equipment with a guard.
  2. Secure guards to the equipment or equipment base but do not bridge sound or vibration isolation.

### 3.21 PIPE LEAKAGE TESTING:

1. Before new piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test all piping for leakage. Where tests are to be witnessed, arrange for the appropriate people to be present.
2. Drainage & Vent Piping: Securely close all openings and pipe ends and perform a water and/or air pressure test in accordance with local plumbing code. After the fixtures and fittings are set and the pipes connected to the building drain or drains, turn on water into all pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Make a smoke test and/or ball test if required by local plumbing code.
3. Forced Sanitary and Storm Drainage lines: Test piping with cold water at a pressure of 1-1/2 times normal working pressure and maintain the pressure for a minimum of two hours.
4. Potable Water Piping: Test piping with cold water at a pressure of 1-1/2 times normal working pressure and maintain the pressure for a minimum of two hours.
5. Sprinkler System Piping: Test all system piping with cold water in accordance with requirements of NFPA No. 13, "INSTALLATION OF SPRINKLER SYSTEMS", and in accordance with any additional requirements of governing authorities.
6. Heat Transfer System Piping: Test piping with cold water at a pressure of 1035 kPa (150 psi) for a minimum of two hours.
7. Steam & Condensate Piping (Humidifier): Test piping with cold water for a minimum of two hours at the following pressures:

1. 0 kPa (0 psi) to 105 kPa (15 psi) low pressure piping - 690 kPa (100 psi)
2. 110 kPa (16 psi) to 690 kPa (100 psi) medium pressure piping - 1035 kPa (150 psi)
3. 690 kPa (100 psi) and greater high-pressure piping - 1380 kPa (200 psi)
8. Natural Gas Piping: Test piping in accordance with the requirements of CAN 1- B149.1. After completion of the verification test, locate the required tag stating the results of the verification test at the point of entry of the gas main into the building, affixed to the pipe in a secure manner. Check all piping joints and connections for leaks with a water/soap solution while the piping is under pressure.
9. Compressed Air Piping: Test piping with dry compressed air at 690 kPa (100 psi) for a minimum of two hours. Test all piping joints with a water-soap solution while the piping is under pressure to detect leaks.
10. Refrigerant Piping: Test refrigerant piping for leakage and dehydrate in accordance with requirements of the 2010 ASHRAE HANDBOOK - REFRIGERATION.
11. Temporarily remove or valve off all piping system specialties or equipment which may be damaged by test pressures prior to pressure testing the systems, and flush piping to remove foreign matter.
12. When testing is carried out below the highest level of the particular system, increase the test pressure by the hydrostatic head (7 kPa (1 psi) for every 600 mm (24 inches) below the high point).
13. Include for temporary piping connections required to properly complete the tests.
14. Make tight leaks found during tests while the piping is under pressure, and if this is impossible, remove and refit the piping and reapply the test until satisfactory results are obtained.
15. Where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions.
16. Tests may be done in sections, as later approved.
17. In addition to the leakage tests specified above, demonstrate proper flow throughout the systems including mains, connections and equipment, as well as proper venting and drainage. Include for any necessary system adjustments to achieve the proper conditions.

### **3.22 FLUSHING AND CLEANING**

1. Flush and sterilize domestic water mains in accordance with procedures established by AWWA Specification C601.
2. Flush new domestic water piping in accordance with Local and Provincial Codes.
3. Thoroughly flush all other piping installed by this Division.
4. Remove, clean and replace all strainers in systems after flushing.
5. Thoroughly clean all equipment and fixtures, lubricate mechanical equipment, and leave all items in perfect order ready for operation.

### **3.23 FIELD PAINTING**

1. After equipment has been installed and prime painted piping and installation is completed, clean rust and oil from exposed iron and steel work under this Division, whether or not it has been factory prime painted.
2. In all building areas touch up any damage to prime coat resulting from shipping or installation and leave ready for final painting under Finishes.
3. In areas such as mechanical/ electrical equipment rooms, boiler rooms, tunnels, service spaces and fan rooms ...etc.:

1. Paint exposed galvanized metal surfaces with one coat of zinc dust galvanized primer and one coat of 100% Alkyd base enamel in an approved colour.
2. Paint exposed iron or steel work with one coat of chrome oxide phenolic base primer and one coat of 100% Alkyd base enamel in an approved colour.

**END OF SECTION**

## 1 General

### 1.1 REFERENCE STANDARDS

1. American Society of Mechanical Engineers (ASME)
  1. ASME B40.3, Bimetallic Actuated Thermometers.
  2. ASME B40.100, Pressure Gauges and Gauge Attachments.
2. Ontario Building Code 2012 (OBC)

### 1.2 SUBMITTALS

1. Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
2. Shop Drawings: Submit manufacturer product literature of all equipment in this section; include working ranges of thermometers and gauges.

### 1.3 DELIVERY, STORAGE AND HANDLING

1. Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.
2. Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
3. Store at temperatures and conditions recommended by the Manufacturer.

## 2 Products

### 2.1 PIPELINE PRESSURE GAUGES

1. Pressure Gauges: Round, 100 mm or 115 mm (4" or 4 ½") diameter, adjustable (90°) angle bimetal dial type, glycerine filled, each accurate to within 1% of scale range and complete with:
  1. Dust-tight, stainless steel (type 304) case with relief valve and polished stainless steel stem, stainless steel rotary geared movement, with stainless steel bushings and socket.
  2. Clear acrylic window, black pointer, with white face, and black lettering.
  3. Dual scale (psi and kPa) with a scale range to cover twice the average working pressure of the equipment and shall be compound gauges on pump suction for all open systems.
  4. Provincial Boiler and Pressure Vessel Safety Branches registration number.
2. Pressure Gauge Accessories & Additional Requirements:
  1. Each pressure gauge shall be equipped with a bronze ball valve.
  2. Each pressure gauge for piping and equipment with normal everyday flow shall be equipped with a brass pressure snubber.
  3. When the equipment is subject to vibration, mount the gauge on adjacent wall or on a mounting plate, supported from the floor.
3. Acceptable manufacturers:
  1. H. O. Trerice Co. No. 700 Series.
  2. Weiss Instruments Inc., Model LF402.
  3. Ashcroft Inc., #35-1009-SWL.
  4. Winters Instruments Inc. Model PFP.

### 2.2 MANOMETERS

1. Manometers: Magnehelic gauge type, Round, 100 mm or 115 mm (4" or 4 ½") diameter, each accurate to within 2% of scale range and complete with:
  1. Dust-tight aluminium case, clear acrylic window, black pointer, with white face, and black lettering.
  2. Gauge range shall be 2½ times the maximum filter resistance. Case shall be suitable for duct or plenum mounting.

3. Dual scale (psi and kPa) with a scale range of 0 to 0.5 kPa (0 to 2 in.) with 0.005 kPa (0.02 in.) graduations in both metric and imperial scales.
  4. Provide bracket for mounting gauge on insulated ducts or plenums.
  5. Two 1500 mm (60 in.) lengths of tubing.
2. Acceptable manufacturers:
    1. Dwyer Series 2000 Magnehelic.

### 2.3 PIPELINE THERMOMETERS

1. Thermometers: Round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type, each accurate to within 1% of full scale and complete with:
  1. Dust-tight, hermetically sealed stainless steel case with stainless steel ring, dampened bimetal coil, calibration adjustment screw, 12 mm (½") NPT connection, 6.4 mm (¼") diameter stainless steel stem, and a suitable thermowell.
  2. Clear acrylic window, black pointer, with white face, and black lettering.
  3. Dual scale (Celsius and Fahrenheit), scale range shall typically be from 0 to 115 deg. C. (32 to 240 deg. F.) for hot water and -17 to 49 deg. C. (0 to 120 deg. F.) for chilled water. For fluids outside of typical operating conditions the scale shall range such that the working temperature of the system is the approximate mid-point of the scale.
  4. Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
  5. Thermowells shall be registered with the Provincial Boiler and Pressure Vessel Safety Branch and have a C.R.N. registration number.
2. Acceptable manufacturers:
  1. H.O. Trerice Co. Model B856.
  2. Weiss Instruments Inc., Model 5VBM.
  3. Ashcroft Inc., #50EI Series.
  4. Winters Instruments Inc., Model TBM.

### 2.4 DUCT THERMOMETERS

1. For ducts with the largest dimension up to 750 mm (30 in.) thermometers shall be similar to pipeline thermometers but with an additional perforated bulb guard and shall be flanged for mounting on ducts.
2. For ducts over 750 mm (30 in.) in largest dimension thermometer: Round, 115 mm (4½ in.) diameter, each accurate to within 1% of full scale and complete with:
  1. Dust-tight, cast aluminum case, vapour filled, 1500 mm (60 in.) minimum length copper averaging bulb with bronze braided armour.
  2. Clear acrylic window, black pointer, with white face, and black lettering.
  3. Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for heated supply air, 0 to 80 deg. C. (32 to 175 deg. F.) for cooled supply, mixed and return air and -40 to 90 deg. C. (-40 to 195 deg. F.) for outside air but range shall suit maximum and minimum temperature of location and shall be shown on Shop Drawings.
  4. Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
  5. Flanged for mounting on ducts.
  6. For insulated ducts or plenums provide a bracket for mounting thermometer clear of insulation.
3. Acceptable manufacturers:
  1. H.O. Trerice Co., Model 80445.
  2. Weiss Instruments Inc., Model 45VA3
4. Thermometers for remote reading shall be similar to duct thermometers specified above but with armoured extension capillary and bulb with separable well for pipelines or flanged duct connection for averaging bulb, as required.



### 3 Execution

#### 3.1 GENERAL INSTALLATION OF METERS OF GAUGES

1. Locate, mount, and adjust all thermometers and pressure gauges so they are easily readable from the floor or platform.
2. Where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading gauges and/or thermometers.
3. Locate remote instruments next to the point of the reading, on wall or structure.
4. Each remote or panel mounted instrument shall have an engraved lamacoid nameplate identifying the system and service.

#### 3.2 INSTALLATION OF PRESSURE GAUGES

1. Insert pressure gauges into equipment tappings or in pipelines using screwed tees or forged steel couplings welded into the lines.
2. For pressure gauges in piping at equipment locations, install the pressure gauge between the equipment and the first pipe fitting.
3. Pressure gauge piping shall be of the same material as the pipe it is attached to.
4. Provide pipeline pressure gauges in the following locations:
  1. City potable water line where it enters the building.
  2. Outlet of the building backflow preventer assembly.
  3. Inlet and outlet of all individual backflow preventers distributed throughout the facility.
  4. Inlet and outlet of each water softener assembly
  5. Inlet and outlet of all pressure reducing valves,
  6. Inlet and outlet of all domestic water booster pumps,
  7. Inlet of each hydronic loop make-up water line.
  8. In valved tubing across the suction, suction strainer (if applicable), and discharge piping of each circulating pump.
  9. In the supply and return piping of each heat exchanger, condenser, cooler or other type of equipment.
  10. In expansion piping to expansion tank(s).
  11. In separate domestic hot water storage tank(s).
  12. Wherever else shown and/or specified on the Drawings or in the Specification.
5. Provide duct pressure gauges in the following locations:
  1. Install manometer at each bank of filters to show the resistance to air flow through the filters. Where prefilters and final filters are mounted in a common frame it is only necessary to provide a single manometer to show the resistance across the total filter assembly. Where filters are separately mounted in individual frames provide a manometer for each set of filters.

#### 3.3 INSTALLATION OF THERMOMETERS

1. Insert pipeline thermometer into tanks, equipment tappings or in pipeline using screwed tees or forged steel couplings, welded into the lines.
2. Duct thermometers shall be attached to duct using sheet metal screws through thermometer flange.
3. Provide pipeline thermometers (angle type or straight type (as required)) in the following locations:
  1. In and out of each water coil or other coil, handling liquid, except individual reheat coils in ductwork.

2. On each branch of 3 port control valves, excluding valves on fan coil, or individual reheat coils in ductwork.
  3. In the supply and return piping of each heat exchanger, condenser, cooler, hot or cold water storage tank, or other type of equipment.
  4. Each heating/chilled water return and each heating/chilled water supply for each main system.
  5. Wherever else shown and/or specified herein or on the Drawings
4. Provide duct thermometers at the following locations in ducts or plenums:
    1. Upstream and downstream from each coil, spray or humidifier, except individual reheat coils in ductwork.
    2. On each of 3 ducts or plenums at mixing dampers.
    3. Return air from each zone.
    4. Outside air entering air handling units.
    5. Wherever else shown and/or specified on the Drawings or in the Specification.
  5. When a common supply header provides the same temperature water to many coils or to many zones, provide a thermometer on the common header only, rather than a thermometer on each branch.
  6. Where a common duct or plenum provides the same temperature air to many zones, provide a thermometer on the common duct only, rather than at each branch of a zone.
  7. Provide thermowells for thermometers where shown. Thermowells shall be compatible with the thermometers used. Provide a coat of metallic base heat transfer paste or grease in the piping well.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This Section covers the work of designing, fabrication and installation of pipe support systems for process and building mechanical piping systems unless the pipe support has been detailed elsewhere in the Contract Documents.

### **1.2 REFERENCE STANDARDS**

1. The American Society of Mechanical Engineers (ASME):
  1. ASME B31.1, Power Piping.
  2. ASME B31.9, Building Services Piping.
2. American Society for Testing and Materials (ASTM):
  1. ASTM A123/A123M, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
  2. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process.
3. Canadian Standards Association (CSA Group):
  1. CSA B214, Installation Code for Hydronic Heating Systems.
4. Manufacturers Standardization Society (MSS):
  1. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Applications and Installation.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  1. ANSI/SMACNA 006, HVAC Duct Construction Standards - Metal and Flexible
6. Ontario Building Code (OBC).

### **1.3 SUBMITTALS**

1. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Shop Drawings:
  1. The Contractor shall submit shop drawings and design calculations showing all anchors and guides for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. The drawings shall be sealed and signed by a Professional Engineer licensed to practice in the Province of Ontario.
  2. The drawings shall include all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the Consultant. Make adjustments as necessary to satisfy the requirements of the Structural Division.
  3. The drawings shall identify each support, hanger, guide, and anchor type by catalogue number and Shop Drawing detail number. No anchor points shall be permitted without reviewed shop drawings and, where installed prior to review, shall be removed and replaced to the satisfaction of the Consultant.
  4. Metal Framing Support Systems: Detailed installation drawings, catalogue information, and complete component specifications.
  5. Pipe, ductwork, equipment, electrical conduits, control equipment and panels (ALL mechanical and electrical systems) etc., supports and anchorage designed to the requirements of a post-disaster facility shall require additional submittals as listed in Section 20 05 50– Seismic Restraint System.
3. Information Submittals: Maintenance information on the piping support system.

#### 1.4 DESIGN REQUIREMENTS

##### 1. General:

1. Piping and equipment provided under the Mechanical Division shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.
2. Hangers, supports, anchors, guides, and restraints shall be selected to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment.
3. Design pipe supports and anchorage for vertical and lateral loading in accordance with the Ontario Building Code for post-disaster structures. See Section 20 05 50– Seismic Restraint System for further requirements.
4. The Contractor shall design, select, and space the hangers/supports in accordance with:
  1. Ontario Building Code for plumbing piping
  2. NFPA 13 and/or NFPA 14 as applicable for fire protection piping
  3. ASME B31.9, Building Services Piping for hydronic piping
  4. The design and selection shall consider the following factors as per MSS Standard Practice Manual SP-58, "Pipe Hangers and Supports – Materials, Design and Manufacture" to prevent swaying, buckling, and to control the effects of thrust:
    1. Pipe weight (wall thickness/pipe schedule).
    2. Configuration (additional requirements for supports at or near every change of direction, take off, etc.).
    3. Additional weight (load) of insulation (type and thickness).
    4. Additional supports for valves, circulators, meters, instruments, and other equipment.
    5. Pipe contents (water, glycol, air, etc.).
    6. Pipe expansion/contraction.
    7. Operating temperature (increased sagging/deflection at high temperatures).
    8. Limitation of structural attachments to pipe supports.
    9. Criticality of system (potential extent of damage to the building and occupants).
    10. Vibration (pulsating systems require additional support to minimize natural frequency of piping system).
5. Any modification to the piping layout, including the addition of flexible joints where not shown on the Contract Drawings, shall require the review and approval by the Consultant.

##### 2. Pipe Support Systems:

1. Design pipe support system within the spans and component requirements specified in the Contract Documents.
2. Generally, the piping supports specified to be designed, supplied and installed by the Contractor are not shown on the Contract Drawings. The absence of pipe supports and details on the Contract Drawings shall not relieve the Contractor of its responsibility for sizing and providing supports.
3. Criteria for Structural Design and Selection of Pipe Support System Components:
  1. Dead loads imposed by the weight of the pipes filled with water, except air and gas pipes within the specified spans and component requirements, plus any insulation.
  2. Design for seismic loads as referenced in item 1.5.1.3 of this Section.
  3. Safety Factor for drilled-in Concrete Anchors (for example, Hilti type anchors):  
Minimum of 5.
4. Design, size, and space support anchoring devices, including lateral supports, anchor bolts, inserts, and other devices used to anchor the support, to withstand the shear and pullout loads imposed by loading and spacing on each particular support.
5. Steel Framing Support System:

1. Bending Members: Size such that beam stress does not exceed allowable stresses in accordance with the requirements of the NBC and maximum deflection does not exceed 1/240 of span.
2. Compression Members: Size in accordance with the manufacturer's recommended method.
3. Support Loads: Calculate using weight of pipes filled with water or glycol (as applicable).
3. Pipe Support Spacing:
  1. Vertical Supports:
    1. Space supports as required to satisfy the requirements in the applicable codes, reference standards, manufacturer recommendations, and good industry practice considering all factors outlined in Article 1.5.A of this specification section.
    2. Note that this spacing may require the use of higher load pipe clamps and more than a single point anchor point in concrete.
  2. Horizontal Supports:
    1. Space supports as required to satisfy the requirements in the applicable codes, reference standards, manufacturer recommendations, and good industry practice considering all factors outlined in Article 1.5.A of this specification section.
    2. Support pipe at changes in direction or elevation and adjacent to flexible joints, couplings, fittings, and valves within 610mm (24 in.) on each side on pipes over 40mm (1½ in.) diameter.
  3. Lateral Supports:
    1. Tie-rods in two directions or combined tension/compression members.
  4. Plastic and Fibreglass Piping:
    1. Space supports as required to satisfy the requirements in the applicable codes, reference standards, and good industry practice considering all factors outlined in Article 1.5.A of this specification section.
    2. As recommended by the manufacturer for the operating temperature in pipe.
  5. Pipe Support Hanger Rods:
    1. Galvanized steel (unless otherwise specified in the Contract Documents), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers.
    2. Sized to suit the loading conditions in accordance with applicable codes, reference standards, manufacturer recommendations, and good industry practice considering all factors outlined in Article 1.5.A of this specification section.
    3. When supporting multiple pipe runs rod size to be in accordance with the Contractor's Professional Engineer design.
4. Thrust Restraint:
  1. Thrust Blocks and Ties: For specified piping systems, thrust blocks, and ties at pipe joints, which are unable to transmit thrust forces, may be shown on the Contract Drawings.
  2. Piping systems shall be analyzed and designed by a Professional Engineer licensed to practice in the Province of Ontario, engaged by and paid by the Contractor. Such piping systems shall be provided with thrust blocks, ties and/or other restraint systems as required to resist all internal and external forces on the piping system. The Contractor-provided design shall provide as part of the shop drawing submittal process information on lateral deflection, axial strain and any resulting unbalanced forces on equipment or connecting piping systems.

5. Duct Support Spacing:

1. Unless otherwise specified or shown maximum duct support spacing and hanger construction shall be in accordance with Chapter 5 of SMACNA or the table below:

**Table 1: Maximum Horizontal Duct Hanger Spacing**

Duct Dimension	Hanger Construction
<b>Horizontal rectangular duct</b>	
Up to 1500 mm (60 in.) for Low Pressure Ductwork Only	Two 25 mm (1 in.) x 16 US gauge straps with two screws on side of duct one screw on bottom. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
For all sizes of Medium and High Pressure Ductwork up to 3000 mm (120 in.) and Low Pressure Ductwork from 1525 mm to 3000 mm (61 in. to 120 in.)	50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) trapeze hanger with two 9 mm (3/8 in.) dia. rods. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
3000 mm to 6000 mm (120 in. to 240 in.)	65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) trapeze hanger with two 9 mm (3/8 in.) dia. rods. Hangers shall be at each joint but in no case more than a maximum 1200 mm (48 in.) on centres.
<b>Horizontal round duct</b>	
Up to 450 mm (18 in.)	One 25 mm (1 in.) x 16 US gauge hanger ring supported from one 25 mm (1 in.) x 16 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
475 mm to 900 mm (19 in. to 36 in.)	One 25 mm (1 in.) x 12 US gauge hanger ring supported from 25 mm (1 in.) x 12 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
925 mm to 1250 mm (37 in. to 50 in.)	One 25 mm (1 in.) x 12 US gauge hanger ring supported from 25 mm (1 in.) x 12 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
1275 mm to 2100 mm (51 in. to 84 in.)	Two 40 mm (1-1/2 in.) x 12 US gauge hanger connected to the 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle girth reinforcing of duct hanger. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.

2. Support all vertical ducts at each floor, on all sides, with angle riveted to the ducts.
3. Support all horizontal ducts within 610mm (24 in.) of each elbow and within 1200mm (48 in.) of each branch intersection.

4. Flexible duct lengths greater than 2,400 mm (84 in.) shall be supported at the midpoint with strap hangers.

### 1.5 DELIVERY, STORAGE AND HANDLING

1. Deliver, store and handle in accordance with Section 01 60 00 - Product Requirements.
2. Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
3. Store at temperatures and conditions recommended by the Manufacturer.

## 2 Products

### 2.1 GENERAL

1. Pipe hanger and support materials, including accessories, shall be, unless otherwise specified in the Contract Documents, constructed in accordance with the MSS Standard Practice Manual SP-58, "Pipe Hangers and Supports – Materials, Design and Manufacture", and, where possible, MSS designations are indicated with each product.
2. Ductwork hanger and support materials, including accessories, shall be, unless otherwise specified in the Contract Documents, constructed in accordance with the SMACNA, "HVAC Duct Construction Standards".
3. All pipe hangers and exposed ductwork hangers shall be zinc plated unless otherwise noted in the Contract Documents.
4. Hangers and supports for insulated piping and ductwork shall be sized to fit around the insulation and covering.
5. All pipe hangers and supports shall be manufactured to the latest requirements of MSS-SP-58. Where applicable, design and manufacture of hangers and supports shall also conform to ANSI/ASME Code for Pressure Piping B31.1
6. When specified proprietary pipe support items are not available, fabricate pipe supports of the specified material and to the general configuration indicated by the Contract Drawings.
7. Special support and hanger details as designed by the Contractor's Professional Engineer may be used for cases where standard catalogue supports are inapplicable or impractical.

### 2.2 HORIZONTAL SUSPENDED PIPING

1. Adjustable Clevis Type: MSS SP 58, Type 1.
  1. Anvil International Inc.; Fig. 260
  2. Cooper B Line Inc.; Fig. B3102
  3. Taylor/Walraven; #24
2. Adjustable Split Ring Pipe Clamp: MSS SP 58, Type 6 or 12.
  1. Anvil International Inc.; Fig. 104
  2. Cooper B Line Inc.; Fig. B3198H
  3. Taylor/Walraven; #38R
3. Adjustable Swivel Ring Band: MSS SP 58, Type 10
  1. Anvil International Inc.; Fig. 69
  2. Cooper B Line Inc.; Fig. B3170
4. Adjustable Roller Hanger c/w Steel Protection Saddle: MSS SP 58, Type 41, 43 or 45 c/w Type 39
  1. Anvil International Inc.; Fig. 171, 177 or 181 c/w Figure 160 to 166A
5. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

### 2.3 TRAPEZE TYPE SUPPORT SYSTEMS

1. Trapeze Hanger/Support: MSS SP 58, Type 59
2. Channel Size: to meet design requirements. Minimum 12 gauge, 1 5/8 inch wide steel. Minimum 1 1/2 inch wide FRP.
3. Members and Connections: Design for all loads with safety factor of 5.
4. Pipe Anchors Type: Galvanized steel anchor chair with U bolt strap.
5. Manufacturers:
  1. Anvil International Inc.; Power Strut.
  2. Cooper B Line Inc.; Strut System.
  3. Unistrut Corporation.
  4. TYCO Inc. - Aickenstrut (FRP).
  5. Gripple Inc.
  6. Eaton
  7. Commercial Roll Formed Products Ltd.
  8. Aimco International Group

### 2.4 HORIZONTAL PIPE ON VERTICAL SURFACES:

1. Steel offset pipe clamp:
  1. Anvil International Inc.; Fig. 103
  2. E. Myatt & Co. Inc. Fig. 170
2. J-Hanger, MSS SP 58, Type 5:
  1. Anvil International Inc.; Fig. 262
  2. Cooper B Line Inc.; Fig. B3690

### 2.5 WALL BRACKETS

1. Welded Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).
  1. Anvil International Inc.; Fig. 199
  2. Cooper B Line Inc.; Fig. B3067
2. Pipe Anchors Type: Galvanized steel anchor chair with U bolt strap.
  1. One Hole Clamp: Anvil International Inc.; Figure 126.
3. Channel Type:
  1. Unistrut Corporation.
  2. Anvil International Inc.; Power Strut.
  3. Cooper B Line Inc.; Strut System.
  4. TYCO Inc. - Aickenstrut (FRP).
  5. Gripple Inc.

### 2.6 VERTICAL RISERS THROUGH FLOORS:

1. Riser clamp, MSS SP 58, Type 8:
  1. Anvil International Inc.; Fig 121,
  2. E. Myatt & Co. Inc. Fig. 151
  3. Taylor/Walraven; #82
2. Heavy-duty steel riser clamp MSS SP 58, Type 8:
  1. Anvil International Inc.; Fig. 261
  2. E. Myatt & Co. Inc.; Fig's. 182,183, 190 and 191



3. Base of Vertical Risers: Support for vertical risers in excess of 6 m (20') high extending out from base mounted equipment shall consist of a base elbow support with flange Empire Tool & Mfg. Co. Fig. 830 or approved equivalent.

## **2.7 VERTICAL PIPING ON VERTICAL SURFACES:**

1. Adjustable Split Ring Pipe Clamp: MSS SP 58, Type 6 or 12.
  1. Anvil International Inc.; Fig. 104
  2. Cooper B Line Inc.; Fig. B3198H
2. Steel offset pipe clamp:
  1. Anvil International Inc.; Fig. 103
  2. E. Myatt & Co. Inc. Fig. 170
3. Heavy-duty steel pipe strap: MSS Type 26
  1. Anvil International Inc.; Fig. 262
  2. E. Myatt & Co.; Fig. 161

## **2.8 PIPE GUIDES**

1. Intermediate Guides:
  1. Piping 150 mm and Smaller: Specify the use of pipe clamp with oversize pipe sleeve to provide a minimum of 3 mm of clearance.
    1. Manufacturers:
      1. Kin Line, Inc., Figure 417.
      2. Grinnell (division of Tyco Fire Products LP): Power Strut, Figure P5932.
  2. Piping 200 mm and Larger: Specially formed U bolts with double nuts to provide a minimum clearance of 6 mm around pipe.
    1. U Bolt Stock Size:
      1. 200 mm Pipe: 16 mm U bolt.
      2. 250 mm Pipe: 400 mm U bolt.
      3. 300 through 400 mm Pipe: 22 mm U bolt.
      4. 450 through 760 mm Pipe: 25 mm U bolt.
2. Alignment Guides:
  1. Piping 200 mm and Smaller: Galvanized steel spider or sleeve type.
  2. Piping 250 mm and Larger: Galvanized roller type guides.
  3. Manufacturers:
    1. Vibrant Power Inc.
    2. Senior Flexonics Canada Ltd.
    3. Kin-Line Inc.

## **2.9 THERMAL BREAKS**

1. All insulated piping shall be provided with a continuous thermal break between the outer pipe diameter and the pipe hanger/support.
2. Calcium silicate (or approved equivalent high density insulation) pre-insulated support shield c/w galvanized steel jacket.
3. Manufacturers:
  1. Cooper B Line Inc.; B3380 thru B3387
  2. National Pipe Hanger Corp.; Pro-Shield

## 2.10 ACCESSORIES

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, 28, 29, or 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of the hanger rod it supports.
3. Concrete Anchors:
  1. Hilti (Canada) Co. type HIT or HSL anchors of size and numbers to resist the design loads based on a Factor of Safety (FOS) of 5.
  2. DeWalt Bantam Plug or equivalent, Plastic Wall Anchors, for lightweight applications only, size and numbers to resist the design loads based on a Factor of Safety (FOS) of 5
4. All fasteners to be sized by the equipment manufacturer.
5. Insulation Saddle:
  1. Type: Galvanized steel or stainless steel, MSS SP 58 and SP 69, Type 40.
  2. Manufacturers and Products:
    1. Anvil International Inc.; Figure 167.
    2. Cooper B Line Inc.; Figure B3151.
6. Vibration Isolation Pads:
  1. Type: Neoprene Waffle.
  2. Manufacturers and Products:
    1. Mason Industries Inc.; Type W.
    2. Korfund Dynamics (division of Aeroflex Inc.); Korpapad 40

## 2.11 ROOF MOUNTED SUPPORTS

1. Lexsoco Corp. Lexcor "Flash-Tite" insulated aluminum support risers with the diameter, height, securement method and flashing to suit the application, channel type aluminum cross members, and galvanized steel pipe hangers and/or supports conforming to MSS SP-58 complete with all required accessories.
2. Portable Pipe Hangers (Canada) Inc. (905-731-8104) "PP" Series or NVENT "CADDY" Series prefabricated portable pipe support system components to suit the pipe, complete with bases, galvanized structural steel frames, and galvanized steel pipe hangers and/or supports conforming to MSS SP-58 complete with all required accessories.
3. Thaler Metal Industries "ARS" and "MERS" series adjustable height, epoxy coated, urethane insulated hollow steel supports including appropriate hardware (adhesive fasteners supplied by others) for fastening to structural roof deck, and cap / plate assembly designed for affixing equipment, piping, or ductwork as shown on drawings; manufacturer's standard urethane insulated 1.6 mm (0.064") mill finish 1100-OT alloy aluminum flashing with EPDM Base Seal. Contractor to select PVC coated deck flange for PVC roof membranes and/or bituminous painted deck flange for BUR and ModBit roof membrane (coordinate with roofing supplier/type). When hanging piping provide galvanized steel pipe hangers and/or supports conforming to MSS SP-58 complete with all required accessories

## 2.12 SPECIAL HANGERS AND SUPPORTS:

1. Vibration isolated supports – Black steel riser clamps as specified above, complete with vibration isolation pads Vibro-Acoustics Ltd. type "NSN" between the clamp and the floor or approved equivalent.

2. For groups of pipes having the same slope – Welded steel brackets Anvil Fig. 195 or approved equivalent, universal trapeze assemblies Anvil Fig. 46, or Unistrut Corporation or approved equivalent assemblies, all with U-bolts, clamps, etc., to secure pipes in place. For pipes 150 mm ("6) and greater Anvil Fig. AS 911 pipe roller with Anvil Fig. 160 to 166A – MSS SP 58, Type 39 steel protection saddle or approved equivalent.
3. For sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS SP 58, Type 48 spring cushions.
4. For plastic piping – generally as specified above but in accordance with the pipe manufacturer's printed recommendations.
5. For bare copper piping – generally as specified above but factory vinyl coated to prevent contact between the pipe and hanger.
6. Special hangers and support – "Gripple Systems" for suspension and bracing of building serviced, generally as specified above but in accordance with the manufacturer's printed recommendations and as approved by Authority Having Jurisdiction.

### 3 Execution

#### 3.1 INSTALLATION OF PIPING SUPPORTS

1. General:
  1. Install pipe support systems in accordance with applicable codes, reference standards, manufacturer recommendations, and good industry practice unless shown otherwise on the Contract Drawings.
  2. Support piping connections to equipment by pipe support and not by the equipment.
  3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
  4. No pipe shall be supported by any other pipe located above, below or beside it.
  5. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
  6. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
  7. Install sway prevention bracing for all suspended piping in accordance with the requirements of NBC.
  8. All drilling for hangers, rod inserts and work of similar nature shall be done by Mechanical Division.
  9. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
  10. Repair mounting surfaces to their original condition after attachments are made.
  11. Install concrete anchors in accordance with the Manufacturer's printed instructions.
  12. Install resilient hangers in accordance with Section 20 05 48 – Vibration & Noise Control.
  13. Install additional seismic supports in accordance with Section 20 05 50 – Seismic Restraint System.
2. Standard Pipe Supports:
  1. Horizontal Suspended Piping:
    1. Single Pipes: Adjustable swivel ring, split ring, or clevis hangers.
    2. Grouped Pipes: Trapeze hanger systems.
    3. Furnish galvanized steel protection shield and oversized hangers for insulated pipe.
    4. Furnish precut sections of rigid insulation with vapor barrier at hangers for insulated pipe.
  2. Horizontal Piping Supported From Vertical Surface:
    1. Single Pipes: Wall brackets or J-Hangers attached to wall with anchors. Clamps attached to wall mounted framing are also acceptable.
    2. Stacked Piping:

1. Wall mounted framing system and clamps acceptable for piping smaller than 75 mm minimal diameter.
  2. Piping clamps that resist axial movement of pipe through support are not acceptable.
  3. Wall mounted piping clamps are not acceptable for insulated piping.
3. Horizontal Piping Supported From Floors:
  1. Stanchion Type:
    1. Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
    2. Use yoked saddles for piping whose centerline elevation is 450 mm or greater above floor and for exterior installations.
    3. Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
  2. Floor Mounted Channel Supports:
    1. Use for piping smaller than 75 mm nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
    2. Attach channel framing to floors with anchor bolts.
    3. Attach pipe to channel with clips or pipe clamps.
  3. Concrete Cradles: Use for piping larger than 75 mm along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
  4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
  5. Standard Attachments:
    1. To Concrete Ceilings: Concrete anchors.
    2. To Steel Beams: I beam clamp or welded attachments.
    3. To Wooden Beams: Lag screws and angle clips to members a minimum of 62.5 mm thick.
    4. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
3. Intermediate and Pipe Alignment Guides:
  1. Provide pipe alignment guides (or pipe supports that provide same function) at expansion joints and loops.
  2. Guide piping on each side of expansion joint or loop at 4 and 14 pipe diameters from each joint or loop.
  3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.
4. Accessories:
  1. Insulation Shield: Install on insulated piping. Oversize rollers and supports.
  2. Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.
  3. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
  4. Dielectric Barrier: 6.4 mm by 75 mm neoprene rubber wrap, oversize clamps
  5. Where factory applied electrical isolation between carbon steel members and copper is not possible wrap pipe with neoprene strip at hanger
  6. Install neoprene between stainless steel supports and non-stainless steel ferrous metal piping.

### 3.2 INSTALLATION OF DUCT SUPPORTS

1. All drilling for hangers, rod inserts and work of similar nature shall be done by Mechanical Division.

2. Hang all ductwork securely and in a rigid manner. Provide hangers as described in Section 1.5 "Design Requirements"
3. Rectangular Duct Support Inside Building: Support horizontal rectangular ducts inside the building in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible but use trapeze hangers with galvanized steel channels and galvanized steel hanger rods for all ducts that are exposed, and all concealed ducts wider than 500 mm (20 in.).
4. Round and Flat Oval Duct Support Inside Building: Support round and flat oval ducts inside the building in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible. Unless otherwise specified in the Contract Documents, for both uninsulated and insulated ducts exposed in finished areas use bands and secure at the top of the duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If the duct is insulated, size the strap to suit the diameter of the insulated duct.
5. Flexible Duct Support Inside Building: Unless otherwise specified in the Contract Documents support in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
6. Install resilient hangers in accordance with Section 20 05 48 – Vibration & Noise Control.
7. Install additional seismic supports in accordance with Section 20 05 50– Seismic Restraint System

### **3.3 INSTALLATION OF ROOF MOUNTED SUPPORTS**

1. Supply supports for roof mounted equipment, piping, and ductwork as indicated on the Drawings.
2. Hand the adjustable structural supports to the roofing trade on the roof for installation and flashing into roof construction as part of the roofing work specified in Division 7. Accurately mark the exact locations and spacing of the 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 piping and ductwork on the angles and provide galvanized steel banding to secure ducts to the angles.
3. Accurately mark the location and spacing of roof support assemblies. At each plastic base location, carefully scrape away loose roof ballast (gravel) and all other debris and dirt. Prime the existing membrane with a primer which is compatible with existing roofing components. Set bases in adhesive in accordance with the manufacturer's installation instructions. Scrape loose ballast back around and on the bases. Install framing, piping, and ductwork on the cross-members. Secure piping and ductwork to cross-members with galvanized steel clamps and banding.
4. Install additional seismic supports in accordance with Section 20 05 50 – Seismic Restraint System.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This section covers the supply and installation of the complete vibration isolation system for all equipment, ductwork, and piping covered by the Contractor.
2. Vibration isolation system shall be fully integrated into and compatible with noise and vibration controls in accordance with 20 05 50 - Seismic Restraint Systems.
3. This specification should be read in conjunction with Section 23 21 16 - Hydronic Piping Specialties and Section 22 11 19 - Domestic Water Piping Specialties for flexible pipe connections and Section 23 33 00 - Air Duct Accessories for the acoustical treatment of ductwork.

### **1.2 REFERENCE STANDARDS**

1. American Society of Heating, Refrigerating, and Air Condition Engineers (ASHRAE):
  1. ASHRAE Handbook: HVAC Applications "Chapter 43 Sound and Vibration Control"
2. Ontario Building Code

### **1.3 SUBMITTALS**

1. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Shop Drawings:
  1. Provide the manufacturer's product literature and datasheets for all components listed in this specification.
  2. Include full details of design criteria, schematics, specifications, installation procedures and instructions.
3. Closeout Submittals:
  1. Provide maintenance data for incorporation into O&M manual.

### **1.4 DELIVERY, STORAGE AND HANDLING**

1. Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.
2. Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
3. Store at temperatures and conditions recommended by the Manufacturer.

## **2 Products**

### **2.1 GENERAL**

1. All equipment provided for vibration isolation shall be new and manufactured specifically for the purpose intended.
2. All vibration isolation devices shall be Vibro-Acoustics, Kinetics Noise Control or Mason Industries and shall be one manufacturer throughout the project.
3. Provide vibration isolation with integral seismic restraint for equipment intended to provide restraint from seismic and wind forces. Housings shall be capable of withstanding the applicable design forces for the specific installation. Installation shall be in accordance with Section 20 05 50 - Seismic Restraint Systems.

### **2.2 VIBRATION ISOLATION**

1. Type EP (Elastomeric Pad)

1. Type EP shall be 8mm thick ribbed or waffle neoprene pads. Isolator pads shall be selected for less than 80% maximum rated load.
2. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
3. Acceptable Manufactures:
  1. Vibro-Acoustics; Model N.
  2. Kinetics; Model NPD.
  3. Mason Industries; Model W or Super W.
  4. ISOTECH Industries
2. Type MEP (Metal and Elastomeric Sandwich Pad)
  1. Type MEP shall consist of two 8mm thick ribbed or waffle neoprene pads bonded to each side of a 16-gauge stainless or galvanized steel shim plate. Isolator pads shall be selected for less than 80% maximum rated load.
  2. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved shall be installed under the bolt head between the steel washer and the base plate.
  3. Acceptable Manufactures:
    1. Vibro-Acoustics; Model NSN.
    2. Kinetics Model; NGS.
    3. Mason Industries; Model WSW.
    4. ISOTECH Industries
3. Type DDNM (Double Deflection Neoprene Mounts)
  1. Type DDNM shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.
  2. DDNM mounts shall be selected for a static deflection of 9.5mm unless specified otherwise.
  3. Acceptable Manufactures:
    1. Vibro-Acoustics; Model RDM.
    2. Kinetics; Model RD.
    3. Mason Industries; Model ND.
    4. ISOTECH Industries
4. Type DDNH (Double Deflection Neoprene Hangers)
  1. Type DDNH shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel. The diameter of the clear hole in the hanger box shall be at least 19mm larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed the hanger box shall be allowed to rotate through a full 360 degrees without encountering an obstructions.
  2. Unless otherwise specified the static deflection of DDNH hangers shall be 8mm.
  3. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model RHD.
    2. Kinetics; Model RH.
    3. Mason Industries; Model HD.
    4. ISOTECH Industries
5. Type SPM (Spring and Neoprene Mounts)

1. Type SPNM shall have a free standing and laterally stable steel spring without any housing, and two type WP isolation pads sandwiching a 16 gauge stainless or galvanized steel separator plate shall be bonded to the isolator base plate. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall not be less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.
  2. Unless otherwise specified the minimum static deflection of SPNM isolators under actual load conditions for equipment mounted on grade slabs shall be 25 mm (1 in.), and 50 mm (2 in.) for equipment mounted above grade level.
  3. Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
  4. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model FS.
    2. Kinetics; Model FDS.
    3. Mason Industries; Model SLFSW.
    4. ISOTECH Industries
6. Type SPNMS (Spring and Neoprene Mounts – Seismic Restrained)
1. Type SPNMS shall be laterally stable restrained steel spring type. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall not be less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.
  2. Unless otherwise specified the minimum static deflection of SPNMS isolators under actual load conditions for equipment mounted on grade slabs shall be 25 mm (1 in.), and 50 mm (2 in.) for equipment mounted above grade level.
  3. Isolators shall be bolted to the floor and equipment. Provide a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
  4. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model SFS.
    2. Kinetics; Model FHS.
    3. Mason Industries; Model SSLFH.
    4. ISOTECH Industries
7. Type SPH (Spring Hangers)
1. Type SPH shall consist of a steel spring and welded steel housing. Spring diameter and hanger box hole shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19 mm (3/4 in.) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
  2. Unless otherwise specified, the static deflection of SPH hangers under actual load conditions shall be 50 mm (2 in.).
  3. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model SH.
    2. Kinetics; Model SH.
    3. Mason Industries; Model 30.
    4. ISOTECH Industries



8. Type SPNH (Spring and Neoprene Hangers)
  1. Type SPNH shall be as above with the addition of a neoprene element in series with the spring. The neoprene element shall have a deflection of not less than 9mm with a strain not exceeding 15%. Unless otherwise specified, the static deflection of SPNH hangers under actual load conditions shall be 50 mm (2 in.).
  2. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model SHR.
    2. Kinetics; Model SRH.
    3. Mason Industries; Model 30N.
    4. ISOTECH Industries
9. Type CSNM (Constrained Spring and Neoprene Mounts)
  1. Type CSNM shall be a spring and neoprene mount that incorporates a housing which contains unrestrained stable springs with built-in leveling device and resilient vertical limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind loading.
  2. A minimum clearance of 25 mm (1 in.) shall be maintained around the restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Limit stops shall provided minimum 6 mm (1/4 in.) clearance under normal operation, and a neoprene washer shall be installed beneath the bolt head/washer used to restrain the isolator.
  3. For Installations subject to wind load, provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene sleeve.
  4. Provide minimum 6mm thick neoprene acoustical base pad on the underside of the mount unless designated otherwise.
  5. Mount shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
  6. Unless specified otherwise, the minimum static deflection for Type CSNM mounts under actual load conditions shall be 50 mm (2 in.).
  7. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model CSR.
    2. Kinetics; Model FLS.
    3. Mason Industries; Model SLR.
    4. ISOTECH Industries
10. Type SCSNM (Constrained Spring and Neoprene Mounts – Seismic Restrained)
  1. Type SCSNM shall be a spring and neoprene mount that incorporates welded steel housings and heavy top plates containing laterally stable restrained springs with built-in leveling device and vertically restraining limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind or seismic loading.
  2. A maximum clearance of 6 mm (1/4 in.) shall be maintained around the restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Top plate and restraining bolts shall be out of contact with the housing during normal operation.
  3. Provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene sleeve.
  4. Provide minimum 6mm thick neoprene acoustical base pad on the underside of the mount unless designated otherwise.
  5. Mount shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
  6. Unless specified otherwise, the minimum static deflection for Type SCSNM mounts under actual load conditions shall be 50 mm (2 in.).
  7. Acceptable Manufacturers:

1. Vibro-Acoustics; Model SCSR.
  2. Kinetics; Model FLSS.
  3. Mason Industries; Model SLRS.
  4. ISOTECH Industries
11. Type SB (Steel Base)
1. Type SB inertia base which shall be a structural steel base frame with clearance holes located to correspond to the mounting bolt holes of the equipment mounted on the base. Fan bases shall have built-in motor slide rails and shall be reinforced as necessary to withstand belt pull without drive misalignment or base distortion.
  2. The bases shall be constructed with deep angle steel sections with a minimum vertical angle leg of 100 mm (4 in.) for motors of 7.5 hp or less, 125 mm (5 in.) for motors between 7.5 hp and 20 hp, and 150 mm (6 in.) for motors over 20 hp.
  3. Structural steel base frames shall be prime painted (galvanized).
  4. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model S.
    2. Kinetics; Model SFB.
    3. Mason Industries; Model MSLFSW.
    4. ISOTECH Industries
12. Type CB (Concrete Base)
1. Type CB inertia base shall have an integral rectangular structural steel form to which concrete is poured.
  2. Perimeter members shall be beams of depth equal to 10% of the longest span of the base, but not more than 300 mm (12 in.) or less than 150 mm (6 in.) deep. Forms shall include motor slide base and all reinforcing steel. Where anchor bolt locations fall in concrete, the reinforcing steel shall include drilled members with sleeves welded below the steel to accept the anchor bolts. Height saving steel brackets shall be used in all mounting locations.
  3. When the concrete base is T-shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.
  4. Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections.
  5. Height saving brackets or welded steel pockets shall be incorporated to ensure a 50 mm (2 in.) minimum clearance under each inertia base.
  6. The weight of each inertia base shall be sufficient to lower the centre of gravity to or below the isolator support plane.
  7. The structural perimeter frame, mounting templates, height saving brackets, and spring system shall be provided as an assembly by the vibration control vendor.
  8. Structural perimeter frames shall be prime painted (galvanized).
  9. Acceptable Manufacturers:
    1. Vibro-Acoustics; Model C.
    2. Kinetics Model; CIB-L.
    3. Mason Industries; Type KSLFSW.
    4. ISOTECH Industries
13. All spring mounts shall be complete with levelling devices 6 mm (1/4 in.) thick ribbed neoprene sound pads and completely colour coded stable springs.
14. Where steel spring isolation systems are described in the specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 80% of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after spring installation.

15. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.
16. All vibration isolators shall have either known undeflected heights of calibration markings to that, after adjustment, verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to design.
17. All mounts installed outdoors or exposed to high humidity conditions shall have two coats of rust resisting paint and springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized.
18. Neoprene mounting sleeves for hold down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.
19. Grout: Non-shrink, self-levelling grout having ability to withstand thermal, vibratory and impact stresses; "Embeco 636 Grout", "Imperial Grout", or "Sauereisen F-100".

### 3 Execution

#### 3.1 GENERAL

1. Obtain one copy of all Shop Drawings of equipment to be isolated showing weights, shaft centres and all dimensions.
2. On system start-up, inspect the complete installation and provide a report in writing.
3. Furnish concrete bases, including concrete fill, on springs or other vibration isolation materials for mechanical isolation.
4. All floor mounted equipment shall be erected on concrete housekeeping pads, with thickness as identified, over the complete floor area of the equipment, unless shown or specified otherwise. Wherever vibration eliminating devices and/or concrete inertia pads are specified, these items shall be mounted on concrete housekeeping pads.
5. Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.
6. All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 6mm maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as equipment being isolated.
7. Seismic snubbers shall be installed on all equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 3.2mm (1/8 in.). Install seismic restraint devices using methods approved by required submittals for component.
8. Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 50 mm (2 in.) between the bottom of the equipment or inertia base (and height saving bracket) and the concrete housekeeping pad (or bolt heads) beneath the equipment. The clearance shall be checked by the Contractor to ensure that no material has been left to short circuit the vibration isolators. There shall be a minimum 100 mm (4 in.) clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
9. Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.

10. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping and blocked up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.
11. All mechanical equipment not specifically identified in this Section that contains rotating or vibrating elements, and any associated electrical apparatus installed by this Division that contains transformers or inductors shall be installed on Type DDNM, MEP, or EP isolators as appropriate.
12. All wiring connections to mechanical equipment on isolators shall be made with a minimum long flexible conduit installed in a slack "U" shape.
13. Elastomeric isolators that will be exposed to temperatures below 0 deg. C. (32 deg. F.) shall be fabricated from natural rubber instead of neoprene.
14. Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
15. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
16. Fans and air handling units shall be levelled with fans operating before the flexible connectors are attached.
17. All fan bases and isolators shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

### 3.2 INSTALLATION OF VIBRATION ISOLATION

1. Floor Mounted Centrifugal Fans and axial flow fans less than 0.87 kPa (3-1/2 in. W.G.) static pressure and/or under 29.8 kW (40 hp), shall be mounted on a Type SB base with Type SPNM isolators and shall have static deflection shall not be less than 50mm under actual load conditions unless shown otherwise in the Contract Drawings.
2. Floor Mounted Centrifugal Fans and axial fans 0.87 kPa (3-1/2 in. W.G.) static pressure and over and/or 29.8 kW (40 hp) and larger, shall be mounted on Type CB with Type SPNM isolators and shall have static deflection not less than 50 mm (2 in.) under actual load conditions unless stated otherwise on the Contract Drawings.
3. Ceiling Suspended Centrifugal Fans, and axial flow fans shall be mounted on Type SPNH spring isolators. Static deflection of the isolators shall be 50 mm (2 in.) unless shown otherwise on the Contract Drawings. Fans shall be suspended from above only if expressly noted as such on the Drawings and Schedules. Thrust restraint shall be by pre-compressed springs.
4. If the fan to be suspended is not furnished with integral structural frame and external mounting lugs of suitable strength and rigidity, install approved structural base with lugs in the field.
5. Fans in packaged or custom air handling units shall be mounted on a Type SB base with Type SPNM isolators. The static deflection shall not be less than 50 mm (2 in.) under actual load conditions.
6. Structural steel floor supports shall be located beneath the spring isolators and shall be equivalent to the structural perimeter frame of the air handling unit.
7. Vertical in-line pumps floor mounted 6.5 kW (10 hp) and larger except where located on slab-on-grade bolt and grout each elbow support to a Type CB inertia base. The minimum base thickness shall be:

**Table 1: Vibration isolation for vertical in-line pumps.**

<b>Pump Size</b>	<b>Inertia Base Thickness</b>
Pumps 6.5 kW (10 hp) to 18.7 kW (25 hp)	200 mm (8 in.)
Pumps 22.4 kW (30 hp) to 74.6 kW (100 hp)	250 mm (10 in.)
Pumps 93.3 kW (125 hp) and larger	300 mm (12 in.)

1. Mount the base on Type SPNMS isolators.
2. Pour bases on roofing felt and elevate a minimum of 50 mm (2 in.) with mounting adjustment bolts after the pump elbows are grouted to the base.
3. No damping or snubbing materials shall be used. Spring deflection shall be as specified in the Contract Drawings, but in no case less than 25 mm (1 in.) and all mountings shall have 6 mm (1/4 in.) thick neoprene vibration isolation pads at the bottom.
8. Vertical in-line pumps floor mounted 4.9 kW (7-1/2 hp) and smaller and 6.5 kW (10 hp) and larger where located on slab-on-grade, shall be supported on Type SPNMA isolation. Refer to Mechanical Standard Details.
9. Vertical in-line pumps ceiling hung shall be supported by Type SPNH spring isolators. Refer to Mechanical Standard Details.
10. Floor mounted air compressors shall be bolted and grouted to Type CB inertia base supported by Type SPNM isolators. Static deflection of the isolators shall be 50 mm (2 in.) unless shown otherwise on the Contract Drawings. Resilient pipe hangers shall be as specified for piping in Mechanical Rooms.
11. Fan coil units or heat pumps suspended from overhead structure shall be hung on Type SPNH spring isolators. The static deflection of the isolators shall be 50 mm (2 in.).
12. Chillers shall be mounted on a Type SB base with CSNM isolators. Spring deflection shall be 50 mm (2 in.) minimum. If the equipment is suitable and an additional steel base is not required, the equipment can be mounted directly on the isolators.
13. Boilers (slab-on-grade) and gas-fired domestic water heaters shall be mounted on a on Type MEP isolation. If the equipment is suitable and an additional steel base is not required, the equipment can be mounted directly on the isolators.
14. Suspend all piping in Mechanical Rooms on Type SPH or SPNH isolators as required. Where piping is supported from the floor, weld brackets to the piping and support on Type SPNM isolators. Isolators do not replace constant support hangers or mounts.
15. The first isolator both upstream and downstream of equipment on springs shall have a static deflection of 1.5 times the deflection of the vibration isolated equipment to a maximum of 50 mm (2 in.). All other piping supports shall have a static deflection of 25 mm (1 in.) minimum.
16. Where a pipe connects to multiple pieces of equipment in the Mechanical Room the pipe isolators for the entire run shall be chosen to suit the connected equipment of the greatest static deflection.
17. Piping that is connected only to equipment installed on neoprene isolators shall be either supported from the floor by Type DDNM isolators or suspended from the structure on Type DDNH isolators within the Mechanical Equipment Rooms.
18. Flexible piping connectors as specified in Section 23 21 16 - Hydronic Piping Specialties and/or Section 22 11 19 - Domestic Water Piping Specialties shall be installed to connect piping of diameter 50 mm (2 in.) or greater to reciprocating or rotating equipment.
19. Piping attached to either coil sections separated from the fan sections of air handling units by flexible connections as specified in Section 23 21 16 - Hydronic Piping Specialties, or to air handling units with internal isolators meeting the requirements of these specifications is exempt from these requirements and is not considered connected to vibrating equipment.

20. No rigid connections between equipment and the building structure shall be made that degrades the specified noise and vibration control system.
21. Locate isolation hangers with the housing a minimum of 50 mm (2 in.) below but as close as possible to the structure. Where isolator hangers would be concealed by a non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.
22. Ducts shall be connected to fans, fan casings and fan plenums by means of flexible connectors. Flexible connectors shall be installed to prevent metal-to-metal contact across flexible connection. Flexible duct connectors shall not be used outside the Mechanical Room unless expressly shown on the Drawings. Flexible connectors shall be in accordance with Section 23 33 00 - Air Duct Accessories.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. This section covers design, supply and installation of complete Seismic Force Resisting System (SFRS)s for all mechanical and electrical equipment, ductwork, and piping covered by the Contractor (Division 20, 21, 22, 23, 25, 26).
2. SFRS shall be fully integrated into and compatible with noise and vibration controls in accordance with Section 20 05 48 – Vibration Isolation and Noise Control.
3. Systems and equipment shall be required to be operational during and after a seismic event.
4. During a seismic event, SFRS shall prevent systems and equipment from causing personal injury and from moving from normal position.
5. Design shall be by a Professional Engineer specializing in the design of SFRS and registered in Province of Ontario.

### **1.2 REFERENCE STANDARDS**

1. Canadian Standards Association (CSA Group):
  1. CAN/CSA-S832, Guideline for Seismic Risk Reduction of Operation and Function Components (OFCs) of Buildings
2. Manufacturers Standardization Society (MSS):
  1. ANSI/MSS SP-127, Bracing for Piping Systems: Seismic-Wind-Dynamic Design, Selection, and Application.
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
  1. ANSI/SMACNA 006, HVAC Duct Construction Standards - Metal and Flexible
  2. SMACNA, Seismic Restraint Manual - Guidelines for Mechanical Systems and Plumbing Piping Systems
4. Ontario Building Code (OBC)

### **1.3 DEFINITIONS**

1. Relevant Importance Category for the Building in accordance with the Ontario Building Code:
  1. Post-disaster: buildings which are required to be operational after a disaster.
2. SFRS: acronym for Seismic Force Resisting System.
3. SCS: acronym for Slack Cable Restraint System.

### **1.4 SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Shop Drawings shall include:
  1. Full details of design criteria.
  2. Working drawings, materials lists, schematics, and full specifications for all components of each SFRS to be provided.
  3. Design calculations (including restraint loads resulting from seismic forces in accordance with SMACNA Seismic Restraint Manual and National Building Code, detailed work sheets, tables).
  4. Separate shop drawings for each SFRS and devices for each system and equipment.
  5. Identification of location for each device.
  6. Schedules of types of SFRS equipment and devices.
  7. Details of fasteners and attachments to structure, anchorage loadings, and attachment methods.

8. Installation procedures and instructions.
9. These drawings shall be designed and bear the seal of a Professional Engineer licensed to practice in the appropriate discipline and in the Place of Work.
3. After the SFRS/SCS has been installed the manufacturer shall conduct a site visit, and provide a letter of confirmation, stating that system has been installed and is functioning as per the manufacturer design requirements.

### **1.5 DELIVERY, STORAGE AND HANDLING**

1. Deliver, store and handle in accordance with Section 01 60 00 - Product Requirements.
2. Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
3. Store at temperatures and conditions recommended by the Manufacturer.

## **2 Products**

### **2.1 SEISMIC FORCE RESTRAINT SYSTEM (SFRS)**

1. Design, supply and install seismic restraints for all equipment, ductwork and piping covered by Contractor except as noted herein.
2. Design and installation of SFRS shall follow the guidelines listed in CAN/CSA-S832 and the SMACNA Seismic Restraint Manual (unless specifically overridden by this Section). Where contradictions occur the more stringent requirement shall be followed.
3. Provide positive seismic and wind restraints on those all systems and components required by the National Building Code and the Authority Having Jurisdiction (AHJ).
4. Refer to Structural Division for additional information/ requirements (Design Spectral response acceleration for short periods, Site Classification, Acceleration based site coefficient, Importance Factor for Earthquake Loads, Wind reference velocity pressure, etc.) and coordinate anchorage points, location, and installation requirements.
5. Fasteners and attachment points shall resist the same load as seismic restraints.
6. The SFRS shall restrain seismic forces in all directions.
7. SFRS of Piping systems shall be compatible with:
8. Expansion, anchoring and guiding requirements.
9. Equipment vibration isolation and equipment SFRS.
10. SFRS utilizing cast iron, threaded pipe, and other brittle materials shall not be permitted.
11. Attachments to concrete structure:
12. Use high strength mechanical expansion anchors.
13. Drilled or power-driven anchors shall not be permitted.
14. Seismic control measures shall not interfere with integrity of fire stopping.
15. Piping and ductwork crossing building expansion joints shall have provision for building motion.
16. Provide seismic restraints for all flues with a minimum of 1 transverse and 1 lateral brace. Restraints shall be designed as per ductwork of equivalent weight.
17. The SFRS shall provide gentle and steady cushioning action and avoid high impact loads.
18. Unless indicated otherwise indicated, seismic restraints shall be capable of a minimum 2g horizontal force in any direction.
19. The SFRSs shall be from a single manufacturer, acceptable manufacturers:
  1. Kinetics Noise Control Inc.
  2. Mason Industries Inc.



3. Vibro-Acoustics (Swegon Group).
4. Gripple Inc.

## **2.2 SFRS FOR STATIC EQUIPMENT AND SYSTEMS**

1. Floor-mounted equipment and systems:
  1. Anchor equipment to equipment supports.
  2. Anchor equipment supports to structure.
  3. Use size of bolts scheduled in approved shop drawings.
2. Suspended equipment and systems:
  1. Use one or combination of following methods:
  2. Install tight to structure.
  3. Cross-brace in all directions.
  4. Brace back to structure.
  5. Slack cable restraint system.

## **2.3 SFRS FOR VIBRATION ISOLATED EQUIPMENT**

1. Equipment installed on vibration isolation requiring seismic restraint shall be in accordance with Section 20 05 48 – Vibration and Noise Control.

## **2.4 SLACK CABLE RESTRAINT SYSTEM (SCS)**

1. Seismic cable sway bracing restraints shall consist of galvanized steel, or stainless steel in corrosive and or outdoor applications, aircraft cable sized to resist seismic loads with a safety factor of five (5). Cable end connections shall use heavy brackets, thimbles, and wire rope clips or compression sleeves.
2. The SCS shall prevent sway in the horizontal plane, “rocking” in the vertical plane, sliding and buckling in an axial direction.
3. Hanger rods shall be braced to withstand compressive loading and buckling. Hanger rods shall be in accordance with Section 20 05 29 – Hangers and Supports.

# **3 Execution**

## **3.1 INSTALLATION OF SEISMIC FORCE RESTRAINT SYSTEM**

1. General:
  1. Restraining devices must be placed on all sides of equipment.
  2. Secure all control panels to withstand seismic loading.
  3. Provide additional steel brackets, inserts, bolts, cable, etc. to provide seismic restraints.
  4. For vibrating equipment:
    1. The installation of seismic restraints shall not compromise vibration isolation capabilities.
    2. Install vibrating equipment on seismically rated isolators whenever possible.
    3. Where seismically rated isolators cannot be used on vibrating equipment, use non-seismic isolators and provide slack cable restraints.
  5. For non-vibrating equipment, secure the equipment to the structure by:
    1. Bolting directly to the structure.
    2. Use rigid seismic restraints.
    3. Use taught cable restraints - not slack.
    4. Rigid restraints are preferable to cable restraints as cables have no compression load capabilities.
  6. Secure brackets.
  7. Inserts shall be installed in accordance to the manufacturer's recommendations.

8. Prior to the installation of any seismic restraints review with the Structural Consultant the methods of attachment and loads. Be particularly aware of large loads and light steel structures.
  9. Where hanger length for piping, ductwork or equipment at a seismic bracing point exceeds 50f, provide additional rod support in accordance to SMACNA or use Mason SRC clamps.
  10. Where anchor bolt diameter is smaller than bolt hole, such as for a slot hole, use Mason 0.5 fast epoxy putty to fill gaps.
  11. Eleven (11) months after substantial performance, re-torque all bolts for seismic attachment and provide certificate, as part of this work the manufacturer shall verify that the vibration isolation does not interfere with the seismic restraint systems.
2. Ductwork:
1. Provide traverse bracing 9 m o.c. maximum. (Except rectangular ducts 1550 mm and larger in either direction may be braced at 9.8 m o.c.)
  2. Provide longitudinal bracing at 18.3 m o.c. maximum. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it, if the bracing is installed within four feet of the intersection of both ducts and bracing is sized for the larger duct. Duct joints shall conform to SMACNA Duct Construction Standard. All joints in duct sections shall provide a positive fastening together of the section.
  3. A group of ducts may be combined in a larger size frame using the overall dimensions with maximum weight for selection of the members from the schedule on sheet 17 of the SMACNA Guidelines.
  4. Walls (including gypsum-board non-bearing partitions) which have ducts running through them may replace a typical transverse brace. Provide solid blockings around duct penetration at stud wall construction.
  5. Install ducts and pipes not braced with 1150 mm minimum clearance to vertical ceiling hanger wires.
  6. All sheet metal for bracing to be  $F_y$  (yield strength) = 33,000 psi.
  7. Minimum sheet metal for bracing to be 16 ga.
  8. It is the responsibility of the Contractor to ascertain that an appropriate size device be selected for each individual piece of equipment.
3. Piping:
1. Provide restraint details on piping and equipment as follows.
  2. Vertical Piping:
    1. Attachment - Secure vertical piping at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents. Stacks shall be supported at their bases and, if over 2 stores in height, at each floor by approved metal floor clamps.
    2. Screwed pipe - Screwed pipe (I.P.S.) shall be supported at not less than every other storey height.
    3. Copper tubing - Copper tubing shall be supported at each storey for piping 40 mm (1½") and larger diameter, and at not more than 1.8 m (6 ft.) intervals for piping 40 mm (1½") and smaller in diameter.
    4. Support pipes of other materials in accordance with the capability of the pipe to resist seismic loads.
  3. Horizontal Piping:
    1. Supports - Horizontal piping shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
    2. Screwed pipe - Screwed pipe (I.P.S.) or flanged pipe shall be supported at approximately 3 m (10 ft.) intervals.
    3. Copper tubing - Copper tubing shall be supported at approximately 1.8 m (6 ft.) intervals for tubing 40 mm (1½") and smaller in diameter and 3 m (10 ft.) intervals for tubing 50 mm (2") and larger id diameter.

4. Support pipes of other materials in accordance with the capability of the pipe to resist seismic loads.
4. Provide transverse bracings at 12.2 m (40 ft.) o.c. maximum unless otherwise noted.
5. Provide longitudinal bracings at 24.4 m (80 ft.) o.c. maximum unless otherwise noted. When thermal expansion or contraction is involved, provide longitudinal bracings at anchor points. The longitudinal braces and the connections must be capable of resisting the force induced by expansion and contraction.
6. Transverse bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 600 mm (24") of the elbow or tee of similar size.
7. For threaded piping the flexibility may be provided by the installation of swing joints. In welded or solder joint piping the flexibility shall be provided by expansion loops or manufactured flexible connectors. For piping with manufactured ball joints select length of piping offset using "Seismic Drift" in place of "Expansion per Joint" in the manufacturer's selection table. Seismic Drift = 0.015 ft. per foot of height (15 mm/m of height).
8. Do not use branch lines to brace main lines.
9. Trapeze hangers may be used. Provide flexibility in joints where pipes pass through building seismic or expansion joints, or where rigidly supported pipes connected to equipment with vibration isolators.
10. A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
11. Provide large enough pipe sleeves through walls or floors to allow for anticipated differential movements.
12. At vertical pipe risers, wherever possible, support the weight of the riser at a point of points above the centre of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m (30 ft.) o.c.
13. Cast iron pipe of all types, glass pipe and any other pipe joined with a shield and clamp assembly where the top of the pipe is 30 mm (12") or more from supporting structure shall be braced on each side of a change in direction of 90° or more. Riser joints shall be braced or stabilized between floors.
14. For gas piping, the bracing details, schedules and notes may be used except that transverse bracing shall be at 6.1 m (20 ft.) o.c. maximum and longitudinal bracing at 12.2 m (40 ft.) o.c. maximum. NPS 1", 1¼", 1½" and 2" (25, 32, 40 & 50 mm) diameter pipes shall be braced the same as NPS 2½" (65 mm) diameter pipe in the schedule. (No bracing is required for pipes NPS ¾" (20 mm) diameter and smaller.)
15. The seismic bracing and support of fire sprinkler piping is not part of this specification.
16. It is the responsibility of the Contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings.
4. Attachment point and fasteners:
  1. Shall withstand the same maximum load that the seismic restraint is to resist and in all directions.
  2. Pipe installation shall comply with the most stringent requirement of MSS SP-127 or as indicated below.
  3. Install SFRS at least 25mm (1 in.) from all other equipment, systems, and/or services.
  4. Where specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
  5. Co-ordinate connections with all disciplines.
  6. Vertical tanks:
    1. Anchor through housekeeping pad to structure.
    2. Provide steel bands above center of gravity.

7. Horizontal tanks:

1. Provide at least two (2) straps with anchor bolts fastened to structure.

**3.2 INSTALLATION OF SLACK CABLE RESTRAINT SYSTEMS**

1. Connect to suspended equipment so that axial projection of wire passes through center of gravity of equipment.
2. Arrange bushing assemblies for anchor bolts for floor mounted equipment with resilient media between the anchor bolt and mounting hole in concrete base.
3. Arrange bushing assemblies for anchor bolts for wall mounted equipment with resilient media where equipment or equipment mounting channels are attached to the wall.
4. Alignment of restraints shall be installed to avoid bending of cables at connection points or across edges of adjacent equipment or building structure.
5. Piping systems shall provide for transverse SCS at 12.2m (40 ft.) spacing maximum, longitudinal SCS at 24.4m (80 ft.) maximum or as limited by anchor/slack cable performance.
6. Ducted systems shall provide for transverse SCS at 9.1m (30 ft.) spacing maximum, longitudinal SCS at 18.3m (60 ft.) maximum or as limited by anchor/slack cable performance.
7. Brace a change in direction longer than 3.7m (12 ft.)
8. Small pipes may be rigidly secured to larger pipes for restraint purposes, but not the reverse arrangement.
9. Orient restraint wires on ceiling hung equipment at approximately 90° to each other (in plan), tie back to structure at maximum of 45° to structure.
10. Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
11. Tighten cable to reduce slack to 38mm (1-1/2 in.) under thumb pressure. Cable shall not support weight during normal operation.

**END OF SECTION**

## 1 General

### 1.1 REFERENCE STANDARDS

1. Canadian General Standards Board (CGSB):
  1. CAN/CGSB-1.60-M, Interior Alkyd Gloss Enamel.
  2. CAN/CGSB-24.3, Identification of Piping Systems.
2. Ontario Building Code (OBC)

### 1.2 DEFINITIONS

1. For purposes of this Section:
  1. "CONCEALED" means mechanical services and equipment in suspended ceilings, non-accessible chases, and furred-in spaces.
  2. "EXPOSED" means "not concealed" as defined in this Section.

### 1.3 SUBMITTALS

1. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Shop Drawings:
  1. Provide manufacturer product literature identifying size, type, material and colour of labels.

### 1.4 DELIVERY, STORAGE AND HANDLING

1. Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.
2. Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
3. Store at temperatures and conditions recommended by the Manufacturer.

## 2 Products

### 2.1 PIPE IDENTIFICATION

1. Contractor shall identify piping and equipment throughout with labels and direction of flow arrows regardless of whether or not specified elsewhere. Labelling shall be as per Painting Schedule or as requested by Consultant if not covered in Schedule.
2. Pipe Markers and Direction Arrows: This piping identification system lends itself to commercially available pipe markers having standard sizes of lettering and colours. Standard Colours designate classes of materials as follows and are consistent with those specified by CAN/CGSB-24.

Colour	Material
Yellow	Dangerous Materials
Green	Safe Materials
Red	Fire Protection Equipment
Blue	Protective Materials

3. Contractor may use stenciled lettering applied directly to pipe/duct insulation if approved on site by OMR and the Consultant. Contractor shall send samples of stencils and photographs of application on to both OMR and Consultant and receive written approval before application to system. All colours and symbols shall match the pipe markers described in this section. The Contractor shall replace any stenciling deemed as poor workmanship at no additional cost.
4. Standard Pipe Identification:

1. For pipes up to and including 150 mm (6") diameter markers shall be coloured, coiled, semi-rigid vinyl plastic of a length to wrap completely around the pipe, and indoor/outdoor type vinyl ink lettering and directional arrows. Alternatively, use coloured pressure sensitive adhesive-style acrylic markers installed with vinyl banding tape.
2. For pipe larger than 150 mm (6") O.D., the markers shall be coloured, flat (saddle-style) semi-rigid vinyl plastic with two rows of wording and installed using nylon tie wraps provided with the marker or approved alternative. Alternatively, use coloured pressure sensitive adhesive-style acrylic markers installed with vinyl banding tape.
3. Stencilled lettering (black Franklin Gothic) identification and directional arrows for normal flow shall be applied by each colour band.
4. The lettering and arrow size shall be as indicated below:

Pipe Size (mm)	Letter Height (mm)	Arrow Height x Arrow Length (mm x mm)
Greater than 65	50	50 x 150
30 to 65	25	25 x 100
Smaller than 30	12	12 x 50

5. Pipe markers and direction arrows shall be suitable for continuous operating temperatures between -40° and 122°C.
5. Standard Pipe Identification Wording and Colours: Identification wording and colours for pipe identification materials shall be as follows:

Legend	Colour	Symbol
Potable Cold Water	White/Green	DCW
Potable Hot Water	White/Green	DHW
Potable Hot Water Return	White/Green	DHWR
Tempered Potable Water	White/Green	TW
Storm Drainage	White/Green	ST
Sanitary Drainage	White/Green	SAN
Plumbing Vent	White/Green	VENT
Natural Gas	Black/Yellow	NG
Natural Gas Vent	Black/Yellow	NG VENT
Fuel Oil Supply	Black/Yellow	FOS
Fuel Oil Return	Black/Yellow	FOR
Fuel Oil Vent	Black/Yellow	FO VENT
Heating Water Supply	Black/Yellow	HWS
Heating Water Return	Black/Yellow	HWR
Glycol Heating Water Supply	Black/Yellow	GHWS
Glycol Heating Water Return	Black/Yellow	GHWR
Steam (Humidifier)	Black/Yellow	STEAM
Chilled Water Supply	White/Green	CHWS
Chilled Water Return	White/Green	CHWR
Glycol Chilled Water Supply	White/Green	GCHWS
Glycol Chilled Water Return	White/Green	GCHWR
Compressed Air	Black/Yellow	CA
Pressure Washer	Black/Yellow	PW

6. Identification Material Manufacturers: Acceptable manufacturers of identification materials shall be equivalent to SMS "Coil-Mark" or SMS "Building Service Pipe Markers" complete with SMS "Banding Tape" pipe markers:
  1. Smillie McAdams Summerlin (SMS) Ltd.
  2. Brady Worldwide Inc.
  3. Revere-Seton Inc.
  4. Embree Industries Ltd. Execution

## 2.2 EQUIPMENT IDENTIFICATION

1. Equipment Nameplates: Minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, white background – black lettering, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2 ½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Each nameplate shall be complete with bevelled edges and engraved wording to completely identify the equipment with no abbreviations. Wording shall generally be in accordance with the Drawings but must be reviewed by the Consultant prior to engraving. Supply stainless steel screws for securing nameplates in place.
2. Valve Tags: Coloured, 40 mm (1½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match the piping classification 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. For example:

VALVE V12  
200 mm  
CHILL. WATER  
NORMALLY OPEN

## 2.3 DUCT IDENTIFICATION

1. Custom made Mylar stencils with 50 mm (2") high lettering to accurately describe the duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured inks with ink pads and roller applicators. Ink colours shall contrast with the lettering background.
2. Paint: CAN/CGSB-1.60-M in colours specified in the Contract Documents. Non-specified colours to conform to CAN/CGSB-24.3.
3. Letters shall be 50 mm high and directional flow arrows shall be 150 mm long stenciled with specified paint with the following wording:

SUPPLY AIR  
RETURN AIR  
EXHAUST AIR  
TRANSFER AIR  
COMBUSTION AIR

## 3 Execution

### 3.1 INSTALLATION OF MECHANICAL IDENTIFICATION

1. Exposed Piping and Ductwork: Identify exposed piping and ductwork in accordance with Part 2 of this Section in the following locations:
  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. At every change of direction (when another marker is not clearly visible).
  5. On both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified in the Contract Documents.
  6. At 10 m (30') intervals on pipe and duct runs exceeding 10 m (30') in length.
  7. On each side of special valves, special fittings and branch connections.
  8. At least once in each room and at least once on pipe and duct runs less than 10 m (30') in length.
2. Concealed Piping and Ductwork: Identify concealed piping and ductwork in accordance with Part 2 of this Section in the following locations:
  1. At points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas.

2. At maximum 10 m (30') 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. Equipment: Provide an identification nameplate for each piece of equipment, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate all nameplates in the most conspicuous and readable location.
4. Electrical Tracing: For all electrically traced mechanical Work, identification wording shall include the phrase "ELECTRICALLY TRACED".
5. Valve Tagging and Chart: Tag valves and prepare a valve tag chart in accordance with the following requirements:
  1. Attach a valve tag to each new valve, except for valves located immediately at the equipment they control.
  2. Prepare a typed or computer printed valve tag chart to list all tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed).
  3. Frame and glaze one copy of the chart and affix the same to a wall where later directed at the site.
  4. Include a copy of the valve tag chart in each copy of the O&M instructions.
6. Ceiling Tacks or Stickers: Where shut-off valves, control dampers, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in the ceiling panel material, or stickers on the ceiling grid material to indicate locations of the items. Confirm colours prior to installation.

**END OF SECTION**



## **1 General**

### **1.1 SUMMARY**

1. TAB means testing, adjusting and balancing equipment to ensure performance in accordance with requirements of Contract Documents and to perform all other work as specified in this section.
2. Standard: TAB shall be performed in accordance with the most stringent of TAB standards of AABC, NEBB, SMACNA and ASHRAE.
3. Perform TAB of all systems, equipment, components, controls specified in the Mechanical Division.

### **1.2 REFERENCE STANDARDS**

1. National Standards for Total System Balance (AABC)
2. American Society of Heating Refrigerating, and Air Conditioning Engineers (ASHRAE)
3. National Building Comfort Testing Association (NBCTA)
4. National Environmental Building Bureau (NEBB)
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
6. Ontario Building Code (OBC)

### **1.3 THE TAB CONTRACTOR**

1. The Contractor in consultation with the Consultant shall appoint a TAB Contractor to measure and report TAB results to the Consultant. The Contractor shall submit a proposal to the Consultant for assessment before any selection of the TAB Contractor is made. The proposal shall include:
  1. Experience in projects of this size.
  2. Labour costs per hour plus a maximum upset limit.
  3. Personnel to be used.
  4. Equipment to be used for the testing and balancing of the systems.
  5. Test procedures and methods.
  6. Any other items requested.
2. Names of all personnel proposed to perform TAB shall be submitted to and approved by the Consultant within 90 days of the award of the contract.
3. Qualifications: Personnel performing TAB shall be current member in good standing of AABC, NEBB, or NBCTA.
4. Suggested Testing and Balancing Agents: Design Test & Balancing Co. (905-886-6513), John Price Enterprises (416-755-4676), Airwaso (519-652-4040), Technical Aire Balancing Inc (416-492-9408), Air Adjustments & Balancing Inc. (416-254-3004) and Flowset Balancing Ltd. (416-410-9793).

### **1.4 SUBMITTALS**

1. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Pre-mobilization
  1. Submit to the Consultant, prior to the commencement of TAB, the following:
    1. Proposed methodology and procedures for performing TAB if different from referenced standard.
    2. Proposed check lists and report forms.
3. Preliminary TAB Report

1. Submit for checking and approval of the Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include the following:
  1. Details of instruments used.
  2. Details of TAB procedures employed.
  3. Calculations procedures.
  4. Summaries.
4. Tab Report
  1. TAB report shall show all results in SI units and shall include:
    1. Tabulated data from air and piping system measurements; see Article 3.5 and 3.6.
    2. Project record drawings used to show testing locations.
    3. System schematics.
  2. Submit electronic copy of the initial TAB Report to the Consultant for verification and approval, if requested submit one paper copy complete with index tabs.
  3. Provide three copies of the final TAB report. Reports shall be complete with index pages and index tabs and certified by the TAB Contractor. Any diagram as single line representation of a Mechanical System specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to the consultant.

#### 1.5 QUALITY ASSURANCE

1. The work specified in this section shall be performed by an Independent Agency specializing in this type of work.
2. Balancing (of both air and piping systems) and sound level readings shall be performed by the same agency.
3. Balancing procedures shall be in accordance with the latest, current requirements of "National Environmental Balancing Bureau" (NEBB) or "Associated Air Balance Council" (AABC), including the following:
  1. NEBB Procedural Standards For Whole Building Systems Commissioning Of New Construction;
  2. NEBB Procedural Standards For Testing Adjusting And Balancing Of Environmental Systems;
  3. NEBB Procedural Standards For Retro- Commissioning Of Existing Buildings;
  4. AABC National Standards for Total System Balance;
  5. AABC Test and Balance Procedures;
4. TAB of systems and equipment regulated by codes, and/or standards shall be tested and balanced to the satisfaction of the National Building Code.

#### 1.6 SCOPE OF TAB

1. The following systems shall be tested, adjusted, and balanced:
  1. Air conditioning, ventilation and heating systems
  2. Air distribution (supply, return and exhaust)
  3. Miscellaneous ventilation or exhaust systems
  4. Computer Room A/C units
  5. Chillers and chilled water distribution (includes glycol system)
  6. Boilers and heating water distribution (includes glycol system)
  7. Plumbing systems
  8. All process piping including natural gas, oil, compressed air, etc.

## **2 Products**

### **2.1 NOT USED**

## **3 Execution**

### **3.1 PURPOSE OF TAB**

1. Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.
2. Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions.
3. Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.
4. Report all values back to Consultant.

### **3.2 COORDINATION**

1. Schedule time required for TAB (including repairs, re-testing) into the Work construction and completion schedule so as to ensure completion prior to the acceptance of project.
2. Perform TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.
3. The TAB Contractor shall co-ordinate with the Contractor to ensure that all necessary control and balancing valves (waterside) as well as manual and splitter dampers (air-side) for balancing are installed in all locations required. Notify the Consultant in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding valves, dampers, locations, installation, etc. If this TAB Contractor fails to co-ordinate with the Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by the TAB Contractor at no cost to the Owners.
4. The TAB Contractor shall not disconnect any control device. Command control devices and enter adjusted set points into the building automation system with tools and training that are furnished under Section 25 00 00 – Building Automation System (BAS). If the TAB Contractor fails to co-ordinate with Section 25 00 00 – Building Automation System (BAS) and if failure to co-ordinate results in any cost, the cost of any change required shall be paid by the TAB Contractor at no cost to the Owner.
5. The Contractor will provide new filters, etc. required for the measurements taken by the TAB Contractor.
6. The Contractor shall provide copies of all Shop Drawings requested by the TAB Contractor.
7. The Contractor shall make staff available, as required by the TAB Contractor, to operate the equipment to take measurements and to correct any deficiencies in the mechanical systems which prevent the TAB Contractor from balancing the system.
8. The Contractor shall ensure access is provided to all valves, dampers, fire dampers, and other equipment that requires servicing.
9. The Contractor shall confirm Start-Up and Operation of Equipment for the TAB Contractor:
  1. Follow start-up procedures as recommended by the equipment manufacturer unless specified otherwise in the Contract Documents.
  2. Follow special start-up procedures specified in the Mechanical Division
  3. Operate systems for length of time required for TAB and as required by the Consultant for verification of TAB reports.
  4. Coordinate with Commissioning Agent as required.

### 3.3 TESTING, ADJUSTING, AND BALANCING

1. The TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.
2. The TAB Contractor shall balance all air systems to ensure all fans, VAVs, FCUs, and AHUs are operating to design conditions. Adjust air volumes and control settings under maximum system pressure drop conditions by means of balancing dampers and record balance position.
3. The TAB Contractor shall balance all piping systems to ensure all boilers, chillers, pumps, heat exchangers, AHUs, FCUs, cabinet/unit/other heaters, domestic hot water balancing valves, etc, are operating to design conditions. Adjust the circuits by means of the balancing valves and record balance position.
4. Pre-Tab Review:
  1. Review contract documents prior to the commencement of the Work and confirm in writing to the Consultant adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.
  2. If testing procedures are to deviate from the specified standards provide the Consultant with all proposed procedures for acceptance.
  3. During construction, co-ordinate location and installation of all TAB devices, equipment, accessories, measurement ports and fittings.
5. Instruments:
  1. Prior to TAB work, submit to the Consultant a list of instruments to be used for TAB together with serial numbers.
  2. Calibrate the instruments in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
  3. Calibrate the instruments within 3 months of the performance of TAB work. Provide certification of calibration to the Consultant.
6. Tolerances:
  1. Perform TAB in accordance with the following application tolerances of design information:
    1. Piping systems: Plus, or minus 10%.
    2. Air systems: Plus, or minus 5%.
  2. Accuracy of measured values shall be accurate to within plus or minus 2% of actual values.
7. Start-up of TAB:
  1. Notify the Commissioning Agent and the Consultant seven (7) days prior to start of TAB.
  2. Start TAB only when the building is essentially completed, including the following components:
    1. Installation of ceilings, doors, windows, other construction affecting TAB.
    2. Application of weather stripping, sealing, caulking.
    3. All pressure, leakage, other tests specified elsewhere; Division 22, 23, 25.
    4. All provisions and components for TAB installed and operational.
    5. Start-up and verification of proper, normal and safe operation of all mechanical systems and associated electrical/control systems affecting TAB including but not limited to:
      1. Proper thermal overload protection in place for electrical equipment.
      2. Air systems:
        1. Filters.
        2. Duct systems clean.
        3. Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
        4. Correct fan rotation.
        5. Fire, smoke, volume control dampers installed and open.

6. Coil fins combed, clean.
    7. Duct access doors installed, closed.
    8. All outlets installed, volume control dampers open.
  3. Piping systems:
    1. Flushed, filled and vented.
    2. Correct pump rotation.
    3. Strainers in place, baskets clean.
    4. Isolation, check, and control valves installed, open.
    5. Calibrated balancing valves installed, at factory settings.
    6. Chemical treatment systems complete, operational.
  3. The TAB Contractor shall balance the air and piping systems as described in Articles 3.5 and 3.6 of this Section. TAB Contractor shall submit an initial TAB Report for Verification.
8. Verification:
  1. After initial balancing all reported results are subject to verification by the Consultant.
  2. In all cases where measurements by the TAB Contractor show failure to comply with the Drawings and Specifications, the Contractor shall change fan sheaves, etc., as required, and new balancing measurements shall be made by the TAB Contractor.
  3. At the time of final review, recheck in the presence of the Consultant random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck shall be selected by the Consultant and be approximately 10% of the report data.
  4. At the time of verification measure space temperature and humidity in a representative number of rooms to verify performance. Tabulate these results and bind into certified report as an appendix.
  5. Number and location of verified results shall be at the discretion of the Consultant. A measured flow deviation of more than 10% between the verification reading and the reported data shall be considered as failing the verification procedure.
  6. Bear costs to repeat TAB and submit new certified reports as required to the satisfaction of the Consultant.
9. Completion of TAB:
  1. TAB shall be considered complete when the final TAB Report is received and approved by the Consultant.
  2. After TAB is completed to satisfaction of the Consultant, replace drive guards, close all access doors, lock all devices in set positions, ensure sensors are at required settings.
  3. Following final acceptance of the certified reports by the Consultant, permanently mark the settings of all valves, dampers, splitters and other adjustable devices so that balance set position can be restored if disturbed at any time. Do not mark such devices until after final acceptance.
  4. Ensure all thermostats and controls are set to give specified conditions and include settings in report.

### **3.4 AIR SYSTEMS TESTING BY TAB CONTRACTOR**

1. Measurements: shall include, but not be limited to the following as appropriate for systems, equipment, components, controls:
  1. Air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dew point), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
2. Locations of equipment measurements shall include, but not be limited to the following as appropriate:
  1. Inlet and outlet of each damper, filter, coil, humidifier, fan, other equipment causing changes in conditions, at each controller, controlled devices.

3. Locations of systems measurements shall include, but not be limited to following as appropriate:
  1. Each main duct, main branch, sub-branch, or run out (or grille, register or diffuser).
4. Duct traverse readings shall be taken through the access ports provided. Where no access ports have been provided new holes shall be made as required. These holes shall be resealed after final readings with sheet metal cover plates and sealant. Duct tape is not acceptable. Where insulation is damaged it shall be repaired including the vapour barrier in an approved manner. Duct tape is not acceptable.
5. Fans on all systems shall be set up to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.

### **3.5 PIPING SYSTEMS TESTING BY TAB CONTRACTOR**

1. Measurements: shall include, but not be limited to the following as appropriate for systems, equipment, components, controls:
  1. Liquid velocity, pressure, flow rate, pressure drop (or loss), temperatures, RPM, electrical power, voltage, noise, vibration.
2. Locations of equipment measurements shall include, but not be limited to following as appropriate:
  1. Inlet and outlet of each heater, tank, pump, circulator, at each controller, controlled device, or fixture. (Includes both hydronic and plumbing systems)
3. Locations of systems measurements shall include, but not be limited to following as appropriate:
  1. Each main, main branch, branch, or sub-branch.
4. Flow through all coils, heat exchangers, chillers, boilers and other such equipment shall be balanced to ensure that the pressure drop through the equipment is within 10% of the manufacturer's design conditions.
5. If the design conditions cannot be met by adjusting the balancing valves throughout the system, or by the adjusted the VFD settings, then pump impellers shall be either changed or trimmed as required.

**END OF SECTION**

1 General

1.1 SUMMARY

- .1 This Section covers the selection and installation of plumbing, process, and building mechanical piping insulation as well as the selection and installation of ductwork insulation unless additional requirements have been detailed elsewhere in the Contract Documents.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
  - .1 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
  - .2 C165: Standard Test Method for Measuring Compressive Properties of Thermal Insulations
  - .3 ASTM C 177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
  - .4 ASTM C 240, Standard Test Methods of Testing Cellular Glass Insulation Block.
  - .5 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .6 ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .7 ASTM C 449, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .8 ASTM C 547, Specification for Mineral Fiber Pipe Insulation.
  - .9 ASTM C 553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .10 ASTM C 612, Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .11 ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
  - .12 ASTM C 921, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
  - .13 ASTM E 96 / E 96M, Standard Test Methods for Water Vapor Transmission of Materials.
- .3 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 International Organization for Standardization (ISO)
  - .1 ISO-6944, Duct 'A' Standard with 1 or 2-Hour External Duct Fire Rating.
- .5 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .6 Underwriters Laboratories of Canada (ULC)

- .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .7 Ontario Building Code 2012 (OBC)

### 1.3 DEFINITIONS

- .1 For purposes of this Section:
  - .1 "CONCEALED" means insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" means "not concealed" as defined in this Section.
  - .3 Insulation systems shall mean insulation material, fasteners, jackets, and other accessories.

### 1.4 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Requirements.
- .2 Shop Drawings:
  - .1 Submit a set of shop drawings identifying each product with the manufacturer's name and insulation type, and the proposed use of the insulation. Include a product data sheet for each insulation type.
  - .2 Include shop drawings of all insulation jacket materials, each identified as to its intended use, and product data sheets for the protective coatings.

### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 - Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

## 2 Products

### 2.1 FIRE HAZARD RATINGS

- .1 All insulation materials shall meet the requirements of CAN/ULC-S700 Series Standards.
- .2 Unless otherwise specified in the Contract Documents, all insulation system materials inside the 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 CAN/ULC-S102.

### 2.2 PIPE INSULATION MATERIALS

- .1 **Flexible Elastomeric Foam:** Closed cell, tubular foamed plastic pipe insulation with a "k" factor of 0.039 W/m°C (0.27 BTU/hr\*ft\*°F) when tested in accordance with ASTM C177 or ASTM C518 at mean temperature 24°C (75°F), 25/50 flame spread/smoke developed rated, with a water vapour transmission rating of 0.08 in accordance with ASTM E 96, Procedure A, and all required installation accessories. Acceptable products are:
  - .1 Armacell LLC "AP Armaflex 25/50" with "Armafix" insulation pipe hangers (IPH)
- .2 **Closed Cell Foamed Glass:** Pittsburgh-Corning "FOAMGLASS", expanded, sectional, rigid sleeve type insulation with a liquid or vapour permeability rating (in accordance with ASTM C240) of 0.00, and a factory applied "PITWRAP SSII" self-sealing jacket secured with, when required. "PITWRAP SS" primer and PC88 adhesive.



- .3 **Preformed Calcium Silicate:** Rigid, sectional sleeve type insulation in accordance with ASTM C533 with a "k" factor of 0.079 W/m°C (0.55 BTU/hr\*ft°F). Acceptable products are:
  - .1 Johns Manville Inc. "Thermo-12 Gold"
  - .2 Calsilite Group (Industrial Insulation Group LLC) Ruston "GOLD"
- .4 **Fire Rated Preformed Fibreglass:** Non-Combustible, fire rated, hollow cylindrical heavy density (min 7 pcf or 112 kg/m<sup>3</sup>) fibreglass units with an all service jacket. Longitudinal joints sealed with metal fasteners or factory-applied self-sealing lap tape. Transverse joints secured with metal fasteners or with butt tape supplied with the product. Pipe covering material as listed as a firestop component in cUL/ULC listed firestop systems, C-AJ-1366, C-AJ-1066, W-J-1127, C-AJ-5125, and C-AJ-8075.
- .5 **Preformed Fibreglass:** Rigid, sectional, sleeve type insulation with a "k" factor of 0.033W/m°C (0.23 @ 75°F) when tested in accordance with ASTM C335 (Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation), and a factory applied vapour retarding jacket (.02 perm). Acceptable products are:
  - .1 Johns Manville Inc. "Micro-Lok H" with "ASJ-SSL jacket"
  - .2 Knauf Insulation Ltd. Earthwool 1000° with ASJ/SSL Pipe Insulation
  - .3 Manson Insulation Products Ltd. "ALLEY K" with "ASJ-SSL" jacket
- .6 **Blanket Fibreglass:** Blanket type roll insulation, 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>) density, with installed "R" value of 0.83 m<sup>2</sup> °C/W (4.7 BTU/hr\*ft°F), and a factory applied vapour barrier facing. Acceptable products are:
  - .1 Johns Manville Inc. Type 150 "Microlite"
  - .2 Knauf Insulation Ltd. Fiber Glass Blanket Insulation with multi-purpose "FSK" facing
  - .3 Manson Insulation Products Ltd. "ALLEY WRAP FSK"
- .7 **Phenolic Foam:** Belform Insulation Ltd. (519-652-5190) "Insulphen" rigid, 32 kg/m<sup>3</sup> (2 lb/ft<sup>3</sup>) density, closed cell sectional pipe insulation and factory fabricated shapes for fittings, with a R Value of 7.7 for 25 mm (1 in.) thick insulation and a factory applied FSK vapour barrier jacket.
- .8 **Pipe Insulation at Hangers and Supports:** Coordinate with discipline responsible for Section 20 05 29 Hangers and Supports to provide thermal breaks as listed here and in section 2.9 of that specification. Insulation shall be a 300 mm (12 in.) long piece of sectional pipe insulation with a thickness equal to the adjacent insulation, a foil and glass reinforced kraft paper vapour barrier jacket, and a minimum 0.80 mm thick (22 ga) G60 galvanized steel shield the same length as the insulation. The insulation shall be:
  - .1 Johns Manville Inc. "Thermo-12 Gold" or Calsilite Group Ruston "GOLD" rigid calcium silicate
  - .2 Belform Insulation Ltd. 60 kg/m<sup>3</sup> (3.75 lb./ft<sup>3</sup>) density "Insulphen" closed cell phenolic foam

## 2.3 WHEELCHAIR LAVATORY PIPING INSULATION KITS

- .1 Removable, flexible, reusable, white moulded plastic insulation kits for a wheelchair lavatory drain piping and potable water supplies exposed under the lavatory. Acceptable products are:
  - .1 Plumberex Specialty Products Inc. "Pro-2000" Series
  - .2 Truebo Inc. "Handi Lav-Guard"
  - .3 TCI Products Inc. "SKAL-GARD"
  - .4 John Manville Inc. Zeston "SNAP-TRAP"

## 2.4 EQUIPMENT INSULATION MATERIALS

- .1 **Blanket Fibreglass:** Blanket type roll form insulation, 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>) density, with a "k" factor (compressed thickness) of 0.035 W/m°C (0.24 BTU/hr\*ft°F), with a factory applied vapour barrier facing. Acceptable products are:
  - .1 Johns Manville Inc. Type 150 "Microlite"
  - .2 Knauf Insulation Ltd. Friendly Feel Duct Wrap with KwikStretch Markings with multi-purpose "FSK" facing
  - .3 Manson Insulation Products Ltd. "ALLEY WRAP FSK"
- .2 **Semi-Rigid Fibreglass Board:** Roll form, moulded insulation, 48.1 kg/m<sup>3</sup> (3.0 lb/ft<sup>3</sup>) density, with a "k" factor of 0.033 W/m°C (0.23 BTU/hr\*ft°F), with a factory applied vapour barrier facing consisting of laminated aluminum foil and kraft paper. Acceptable products are:
  - .1 Johns Manville Inc. "Pipe and Equipment Insulation"
  - .2 Knauf Insulation Ltd. Fiber Glass Pipe and Tank Insulation or KwikFlex Pipe & Tank Insulation
  - .3 Manson Insulation Inc. "AK FLEX"
- .3 **Preformed Calcium Silicate:** Rigid block and/or semi-rigid factory scored block insulation. Acceptable products are:
  - .1 Johns Manville Inc. "Thermo-12 Gold"
  - .2 Calsilite Group (Industrial Insulation Group LLC) Ruston "GOLD"
- .4 **Closed Cell Foamed Glass:** Pittsburgh Corning "FOAMGLAS" expanded, rigid board and block type insulation with a liquid or vapour permeability rating (in accordance with ASTM C240) of 0.00.

## 2.5 DUCTWORK SYSTEM INSULATION MATERIALS

- .1 **Rigid Fibreglass Board:** Preformed board type insulation, 48.1 kg/m<sup>3</sup> (3.0 lb/ft<sup>3</sup>) density, with a "k" factor of 0.033 W/m°C (0.23 BTU/hr\*ft°F @ 75°F mean), with a factory applied reinforced aluminum foil and kraft paper facing. Acceptable products are:
  - .1 Johns Manville Inc. Type 814 "Spin-Glas"
  - .2 Knauf Insulation Ltd. Fiber Glass Insulation Board with FSK facing
  - .3 Manson Insulation Products Ltd. "AK BOARD FSK"
- .2 **Blanket Fibreglass:** Blanket type roll form insulation, 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>) density, 40mm (1.5 in.) thick, with a factory applied vapour barrier facing. Acceptable products are:
  - .1 Johns Manville Inc. Duct Wrap Type 150 "Microlite"
  - .2 Knauf Insulation Ltd. Friendly Feel Duct Wrap with KwikStretch Markings with multi-purpose "FSK" facing
  - .3 Manson Insulation Products Ltd. "ALLEY WRAP FSK"
- .3 **Preformed Calcium Silicate:** Rigid block and sheet insulation. Acceptable products are:
  - .1 Johns Manville Inc. "Thermo-12 Gold"
  - .2 Calsilite Group (Industrial Insulation Group LLC) Ruston "GOLD"
- .4 **Flexible Elastomeric Foam Sheet:** Sheet form, closed cell foamed plastic insulation with a "k" factor of 0.039 W/m°C (0.27 BTU/hr\*ft°F) at mean temp 24°C (75°F) per ASTM C177, 25/50 flame spread/smoke developed rated, with a water vapour transmission rating of 0.08 in accordance with ASTM E 96, Procedure A, and all required installation accessories. Acceptable products are:

- .1 Armacell LLC "AP Armaflex 25/50" Sheet & Roll

## 2.6 FIRE-RATED DUCT WRAP

- .1 Fire resistant duct insulation shall be a flexible high temperature insulation rated for a continuous use limit of 1000°C (1832°F). The insulation shall be blanket type fibreglass duct wrap completely encapsulated in reinforced foil with a nominal thickness of 40 mm (1.5 in.) thick, density of 96 kg/m<sup>3</sup> (6 lbs/ft<sup>3</sup>) and R-Value of 7.3 at 23.9°C (75°F). The duct enclosure system shall be suitable for installation with zero clearance to combustibles with a 1 or 2 hour fire resistance rating to ventilation or pressurization ductwork in accordance with the requirements of ISO 6944. Product shall meet flame spread rating of 25 and smoke developed rating of 50 as per CAN/ULC S102.2. Insulation product shall be complete with all manufacturers standard fastenings, including (where applicable) aluminum foil tape, filament tape, banding materials, pins, cup-head weld pins, and speed clips for a ULC listed installation.
- .2 Acceptable Manufactures:
- .1 CL4 Inc. "CL4Fire"
- .2 3M Canada Inc. "Fire Barrier Duct Wrap 615+"
- .3 Morgan Advanced Materials "FireMaster Fastwrap"

## 2.7 INSULATION FASTENINGS

- .1 **Wire:** Minimum 1.8 mm diameter (15 ga) galvanized annealed wire.
- .2 **Stainless Steel Banding:** Childers Products Co. "FABSTAPS" 0.6 mm (24 ga) Type 304 minimum 12 mm (0.5 in.) wide stainless steel strapping or approved equivalent.
- .3 **Duct Insulation Fasteners:** Weld-on 2 mm (12 ga) zinc coated steel spindles of suitable length, complete with minimum 40 mm (1.5 in.) square plastic or zinc plated steel self-locking washers.
- .4 **Tape Sealant:** Venture Tape Corp. 1525CW, 3M FSK Silver (foil) Facing Tape UL 723 classified (5/10 flame/smoke rating), 3M™ FSK Facing Tape or approved equivalent self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match the surface being sealed.
- .5 **Adhesive - Fibreglass Insulation:** Clear, pressure sensitive, quick setting brush consistency adhesive, non-flammable when wet, fire resistive when dry, suitable for a temperature range of -20°C (-4°F) to 82°C (180°F) and compatible with the type of material to be secured, and WHMIS classified as non-hazardous.
- .6 **Adhesive – Flexible Elastomeric Insulation:** Armstrong World Industries Inc. # 520 air-drying contact adhesive.
- .7 **Adhesive – Phenolic foam Insulation:** As recommended by the insulation manufacturer.
- .8 **Adhesive – Closed Cell Foamed Glass Insulation:** Pittsburgh-Corning PC88 multi-purpose two-component adhesive.
- .9 **Sheet Metal Screws:** No. 10 stainless steel sheet metal screws.

## 2.8 INSULATION JACKETS AND FINISHES

- .1 **White PVC Fitting Covers:** Factory preformed, one-piece, minimum 15 mil thick white PVC covers, 25/50 rated with a semi-luster finish. Acceptable products are:
- .1 Proto Corp. "LoSMOKE"
- .2 Foster Products (H.B. Fuller Construction Products Inc.) "SMOKE-SAFE 25/50 SEALFAS"
- .3 Speedline Corporation The Sure-Fit System "SMOKE-LESS 25/50"

- .4 Johns Manville Inc. "Zeston"
- .5 Belform Insulation Ltd.
- .2 **White Sheet PVC:** Roll form (and fitting covers), minimum 15 mil thick white PVC, 25/50 rated, complete with installation and sealing accessories. Acceptable products are:
  - .1 Proto Corp. "LoSMOKE"
  - .2 Foster Products (H.B. Fuller Construction Products Inc.) "SMOKE-SAFE 25/50 SEALFAS"
  - .3 Speedline Corporation The Sure-Fit System "SMOKE-LESS 25/50"
  - .4 Johns Manville Inc. "Zeston"
  - .5 Belform Insulation Ltd.
- .3 **Coloured Sheet PVC:** Roll form (and fitting covers), minimum 15 mil thick coloured PVC, 25/50 rated, complete with insulation and sealing accessories. Acceptable products are:
  - .1 Proto Corp. "LoSMOKE"
  - .2 Foster Products (H.B. Fuller Construction Products Inc.) "SMOKE-SAFE 25/50 SEALFAS"
  - .3 Speedline Corporation The Sure Fit System "SMOKE-LESS 25/50"
  - .4 Johns Manville Inc. "Zeston"
  - .5 Belform Insulation Ltd.
- .4 **Aluminum:** Smooth aluminum jacket material with a 13 mm (0.5 in.) safety edge in accordance with ASTM B209, 0.6 mm (0.025 in.) thick, factory cut to size and complete with moisture barrier and 50 mm overlap and with stainless steel bands on 300 mm (12 in.) centres. Fittings shall be two piece epoxy coated with silicone joints as required.
- .5 **Stainless Steel:** Smooth type 304 stainless steel jacket material to ASTM A240, 0.4 mm (0.016 in.) thick, factory cut to size, complete with moisture barrier and 50 mm overlap and with stainless steel bands on 300 mm (12 in.) centers. Fittings are to be two piece pressed stainless steel with silicone joints as required.
- .6 **Adhesive Backed Metal Faced Weather Barrier:** Belform Insulation Ltd. "Flex-Clad 400" roll form sheet material with an adhesive backing and an embossed aluminum facing.
- .7 **Factory Applied Insulation Weather Barrier:** Knauf Insulation Ltd. Redi-Klad™ 1,000° pipe insulation, factory applied, five-ply, weather and abuse resistant, 0.0 permeability, embossed aluminum, self-sealing lap pipe insulation jacket. Insulation and jacketing system shall be designed for piping systems operating from -18°C to 538°C (0°F to 1000°F).
- .8 **Insulation Cement:** Heat resistant, trowel consistency thermal insulating and finishing cement to ASTM C-449/C-449M, and suitable in all respects for the application.
- .9 **Protective Coating - Foamed Glass Insulation:** Pittsburgh Corning Co. "PITTCOTE 404" flexible acrylic latex weather barrier coating, white unless otherwise specified in the Contract.
- .10 **Protective Coating - Flexible Elastomeric Foam Insulation:** Armacell LLC "WB Armaflex" white, water based latex enamel, semi-gloss or approved equivalent.

### 3 Execution

#### 3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

- .1 Unless otherwise specified in the Contract Documents, 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 Heating piping in soffits and/or overhang spaces and connected to bare element radiation in the spaces;
  - .4 Branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except wheelchair lavatories;
  - .5 Exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except wheelchair lavatories;
  - .6 Heated liquid system pump casings, valves, strainers and similar accessories;
  - .7 Expansion tanks;
  - .8 Fire protection pump casings;
  - .9 Manufactured expansion joints and flexible connections;
  - .10 Acoustically lined ductwork and/or equipment; and
  - .11 Flexible ductwork.
- 
- .2 Unless otherwise specified or shown in the Contract Documents the installation of piping and ductwork insulation shall be in accordance with the TIAC Mechanical Insulation Best Practices Guide.
  - .3 Install insulation directly over pipes and ducts and not over hangers and supports. Insulation and covering shall pass unbroken through the hangers and supports.
  - .4 Do not apply insulation unless leakage tests have been satisfactorily completed.
  - .5 Ensure that all surfaces to be insulated are clean and dry.
  - .6 Ensure that the ambient temperature is minimum 13°C (55°F) for a minimum of one day prior to the application of insulation, and for the duration of insulation work, and that relative humidity is and will be at a level such that mildew will not form on insulation materials.
  - .7 Install piping insulation and covering continuous through pipe openings and sleeves.
  - .8 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
  - .9 Pipe insulation at hangers and supports shall consist of a minimum of 300 mm (12 in.) long sections of calcium silicate or phenolic foam sectional insulation with vapour barrier jacket. Coordinate with discipline responsible for Section 20 05 29 Hangers and Supports to provide thermal breaks as listed here and in section 2.9 of that specification. Galvanized steel shields shall be provided between the insulation and the hanger or support for all pipe 50 mm (2 in.) diameter and above and not requiring a roller hanger or support. Provide "Armafix" insulation pipe hangers (IPH) for flexible elastomeric foam insulation.
  - .10 Where roller hangers and supports are required for "hot" piping 150 mm (6 in.) diameter and larger, steel protection saddles will be provided as part of the Section 20 05 29 Hangers and Supports work. Pack the saddle voids with fiberglass insulation.
  - .11 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. Insulation on cold piping must not be broken. Saddles that touch the cold piping directly are not acceptable on cold piping.
  - .12 Irregular shaped objects such as strainers, pipe system filters, cyclone separators, blowdown valves and other accessories requiring servicing, on insulated piping, shall be insulated with removable caps or sections. All edges shall be sealed between pipe and vapour barrier and held in place with stainless steel straps. Finish all insulation smooth, making the outline of

- pipe insulation a true circular and concentric shape. Shape the outline of fitted insulation to blend with adjacent covering.
- .13 The final appearance and finish of exposed mechanical Work depends to a large degree on the quality of the insulation application, therefore, a neat and properly finished insulation job will be insisted upon.
  - .14 When insulating vertical piping risers 75 mm (3 in.) diameter and larger, use insulation support rings welded directly above the lowest pipe fitting, and thereafter at 4.5 m (15 ft.) centres and at each valve and flange. Insulate in accordance with Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
  - .15 Where piping and/or equipment is traced with electric heating cable, ensure that the cable has been tested and accepted prior to the application of insulation, and ensure that the cable is not damaged or displaced during the application of insulation.
  - .16 Where existing insulation work is damaged as a result of a new mechanical work, repair the damaged insulation work to new work standards.
  - .17 Where fibreglass rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover the exposed end of the insulation with a purpose made PVC cover on "cold" piping.
  - .18 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.
  - .19 Where thermometers, gauges, etc., occur in insulated piping, and where access to
  - .20 transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in the insulation and provide a suitable grommet in the opening.

### 3.2 PIPE INSULATION REQUIREMENTS – FIBREGLASS

- .1 **Domestic Water:** Insulate the following pipe with fibreglass insulation of the thickness noted below:
  - .1 Potable cold water piping inside building and above ground – 25 mm (1 in.) thick.
  - .2 Potable hot water piping within. operating water temperatures up to and including 60°C (140°F), size of up to and including 32 mm (1.25 in.) – 25 mm (1 in.) thick.
  - .3 Potable hot water piping with operating water temperatures up to and including 60°C (140°F), size of 40 mm (1.5 in.) and larger – 40 mm (1.5 in.) thick.
  - .4 Potable hot water piping with operating water temperatures above 60°C (140°F), size of up to and including 32 mm (1.25 in.) - 40 mm (1.5 in.) thick.
  - .5 Potable hot water piping with operating water temperatures above 60°C (140°F), size of 40 mm (1.5 in.) and larger - 50 mm (2 in.) thick.
  - .6 Tempered potable water piping, up to and including 32 mm (1.5 in.) - 25 mm (1 in.) thick.
  - .7 Tempered potable water piping, 40 mm (1.5 in.) and larger - 40 mm (1.5 in.) thick.
  - .8 Potable hot water recirculation piping with operating water temperatures up to and including 60°C (140°F), size of up to and including 32 mm (1.25 in.) - 25 mm (1 in.) thick.
  - .9 Potable hot water recirculation with operating water temperatures up to and including 60°C (140°F), size of 40 mm (1.5 in.) and larger - 40 mm (1.5 in.) thick.
  - .10 Potable hot water recirculation piping with operating water temperatures above 60°C (140°F), size of up to and including 32 mm (1.25 in.) - 40 mm (1.5 in.) thick.

- .11 Potable hot water recirculation piping with operating water temperatures above 60°C (140°F), size of 40 mm (1.5 in.) and larger - 50 mm (2 in.) thick.
- .12 Non-potable cold water inside building and above ground – 25 mm (1 in.) thick.
- .2 **Drainage, Waste, and Venting:** Insulate the following pipe with fibreglass insulation of the thickness noted below:
  - .1 Storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal mains. Where the roof drain is less than 3 m (10 ft.) from the vertical leader, insulate the first 3 m (10 ft.) of pipe closest to the roof drain including the vertical riser - 25 mm (1 in.) thick.
  - .2 Drainage piping from refrigerated drinking fountains to nearest 75 mm (3 in.) dia. or larger drain pipe – 25 mm (1 in.) thick.
  - .3 Drainage piping carrying chilled condensate to closest branch or main – 25 mm (1 in.) thick.
- .3 **Chilled Water Piping:** Insulate the following pipe with fibreglass insulation of the thickness noted below:
  - .1 Chilled water piping, supply and return, to and including 100 mm (4 in.) diameter – 25 mm (1 in.) thick.
  - .2 Chilled water piping, supply and return, larger than 100 mm (4 in.) diameter – 40 mm (1.5 in.) thick.
  - .3 Chilled glycol solution piping, supply and return, up to and including 100 mm (4 in.) dia. – 25 mm (1 in.) thick.
  - .4 Chilled glycol solution piping, supply and return, larger and 100 mm (4 in.) dia. – 40 mm (1.5 in.) thick.
- .4 **Heating Water Piping:** Insulate the following pipe with fibreglass insulation of the thickness noted below:
  - .5 Hot water heating piping, supply and return, up to and including 32 mm (1.25 in.) dia. – 40 mm (1.5 in.) thick.
  - .6 Hot water heating piping, supply and return, 40 mm (1.5 in.) dia. and larger - 50 mm (2 in.) thick.
  - .7 Glycol solution heating or heat reclaim piping, supply and return, up to and including 32 mm (1.25 in.) dia. - 40 mm (1.5 in.) thick.
  - .8 Glycol solution heating or heat reclaim piping, supply and return, 40 mm (1.5 in.) dia. and larger - 50 mm (2 in.) thick.
  - .1 Boiler feedwater piping – 25 mm (1 in.) thick.
  - .2 Boiler blowdown piping – 25 mm (1 in.) thick.
- .9 **Special Piping:** Insulate the following pipe with fibreglass insulation of the thickness noted below:
  - .1 All piping located outside building or inside building in unheated areas and indicated to be traced with electric heating cable – 50 mm (2 in.) thick.
  - .2 Power washer piping – 25 mm (1 in.) thick.
  - .3 Air compressor set fresh air intake piping – 25 mm (1 in.) thick.
- .10 Piping: Ensure that the overlap flap of the sectional insulation jacket is secured tightly in place. Cover section to section butt joints with tape sealant.

- .11 Fittings: Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket fibreglass insulation to a thickness and insulating value equal to the sectional insulation and secured in place with adhesive and/or wire and covered with PVC fitting covers. Provide sufficient material to prevent the PVC cover from being pushed in or crushed.
- .12 "Cold" Piping Valves, Strainers, etc.: Insulate valves, strainers, and similar piping system accessories in "cold" piping such as potable water piping with cut and tightly fitted segments of sectional pipe insulation with all joints covered with tape sealant, or, alternatively, wrap the piping valve, strainer, etc., with blanket fibreglass and cover with PVC covers as for "Fittings" above.
- .13 Flanges and Mechanical Couplings: Terminate sectional insulation approximately 50 mm from the flange or coupling on each side of the flange or coupling. Cover the flange or coupling with a minimum 50 mm (2 in.) thickness of blanket fibreglass insulation wide enough to butt tightly to the ends of the adjacent sectional insulation. Secure the blanket insulation in place and cover with a PVC cover. Provide sufficient material to prevent the PVC cover from being pushed in or crushed.
- .14 Concealed Rough-In piping at Plumbing Fixtures: Take special care at concealed potable water rough-in piping at plumbing fixtures to ensure that the piping is properly insulated. If necessary due to space limitations, use 12 mm (0.5 in.) thick sectional pipe insulation in lieu of 25 mm (1 in.) thick insulation.
- .15 Alternative Phenolic Foam Insulation: Phenolic foam insulation with a thickness to give an equivalent insulating value to that of the fibreglass insulation and secured in place and sealed in accordance with the manufacturer's recommendations is acceptable in lieu of fibreglass insulation.

### 3.3 PIPE INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC FOAM

- .1 As an alternative for chilled water piping equipment provide flexible elastomeric foam with a thickness to give an equivalent insulating value to that of the fibreglass insulation, secured in place and sealed in accordance with the manufacturer's recommendations.
- .2 Install flexible elastomeric pipe insulation in strict accordance with the manufacturer's published instructions to suit the application, and using adhesive, joint sealants and finish to produce a water-tight installation. Provide Armaflex "Armafix" insulation pipe hangers (IPH) at all support locations.

### 3.4 PIPE INSULATION REQUIREMENTS – CLOSED CELL FOAMED GLASS:

- .1 Install closed cell foamed glass insulation in strict accordance with the manufacturer's published instructions to suit the application, and using adhesive, joint sealants, and jacketing to produce a 100 percent water-tight installation. Insulate the following pipe with closed cell foamed glass of the thickness noted:
  - .1 Electrically heat traced piping outdoors.
  - .2 Exterior piping required to be insulated.

### 3.5 PIPE INSULATION REQUIREMENTS – FIRE RATED INSULATION

- .1 Where pipe which is to be insulated as specified above penetrates fire rated walls and slabs, provide fire-rated, non-combustible sectional insulation on the portion of pipe in the fire barrier and for a distance of 50 mm (2 in.) on either side of the fire barrier.
- .2 Insulation thickness shall be as specified, but in any case, a minimum thickness of 25 mm (1 in.).
- .3 Install insulation in strict adherence with the manufacturer's printed installation instructions unless noted otherwise.

### 3.6 INSTALLATION OF WHEELCHAIR LAVATORY INSULATION KITS



- .1 Provide manufactured insulation kits to cover exposed drainage and water piping under new wheelchair lavatories.

### 3.7 EQUIPMENT INSULATION REQUIREMENTS – BLANKET TYPE FIBREGLASS

- .1 Insulate the following equipment with fibreglass blanket type insulation of the thickness noted below:
  - .1 Chilled water and/or potable cold water pump casings – 40 mm (1.5 in.) thick
  - .2 Roof drain sumps where inside the building - 25 mm (1 in.) thick
  - .3 Water meter(s) - 40 mm (1.5 in.) thick
- .2 Wrap the equipment to a thickness and insulating value equal to an equivalent thickness of rigid sectional pipe insulation. Laminate the insulation in place with adhesive and secure with wire. Apply a jacket of the insulation vapour barrier material secured in place with adhesive or sealant tape.
- .3 Cover roof drain sumps with purpose made PVC fitting covers.

### 3.8 EQUIPMENT INSULATION REQUIREMENTS – SEMI-RIGID FIBREGLASS

- .1 Insulate the following equipment with semi-rigid fibreglass board insulation of the thickness noted below:
  - .1 Heat exchangers – 40 mm (1.5 in.) thick
  - .2 Heating main air separator – 40 mm (1.5 in.) thick
- .2 Install the insulation as required to fit the shape and contour of the equipment. Secure the insulation in place with adhesive, and with aluminum straps on 450 mm centres. Cover the insulation with mesh secured to the metal bands. Lace edges of the wire mesh together. Apply a 6 mm (0.25 in.) thick skim coat of insulating cement, then, when the insulating cement has dried, apply a 6 mm (0.25 in.) thick coat of cement trowelled smooth.
- .3 For “cold” equipment such as the chilled water heat exchangers, prime the 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 all equipment with removable heads to permit the heads to be removed and replaced without damaging the adjacent insulation work.

### 3.9 EQUIPMENT INSULATION REQUIREMENTS – FLEXIBLE FOAM ELASTOMERIC

- .1 As an alternative for “cold” equipment such as the chilled water heat exchangers, pump casings, etc., flexible elastomeric insulation with a thickness to give an equivalent insulating value to that of the fibreglass insulation, secured in place and sealed in accordance with the manufacturer’s recommendations.
- .2 Install flexible elastomeric insulation in strict accordance with the manufacturer’s printed insulation instructions, and insulate all components shown or noted in the instructions. Insulate auxiliary water piping as per chilled water piping. Provide removable sections of insulation at all components that require servicing, and secure with stainless steel straps.

### 3.10 DUCTWORK INSULATION REQUIREMENTS – FIBREGLASS

- .1 Insulate the following ductwork systems with fibreglass insulation of the thickness noted below:

- .1 All fresh air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to the first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and the fresh air is not tempered, then the fresh air ductwork system complete – 50 mm (2 in.) thick
- .2 Mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – 50 mm (2 in.) thick rigid board or 40 mm (1.5 in.) thick flexible blanket
- .3 Supply air ductwork outward from fans, except for supply ductwork exposed in the area it serves – 25 mm (1 in.) thick rigid board or 25 mm (1 in.) thick flexible blanket
- .4 Exhaust discharge ductwork for a distance of 3 m (10 ft.) downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10 ft.) distance – 50 mm (2 in.) thick rigid board or 40 mm (1.5 in.) thick flexible blanket
- .5 Any other ductwork, casings, plenums or sections specified or detailed on the Drawings to be insulated – thickness shall be as specified on the Drawings.
- .2 Insulation for casings, plenums, exposed rectangular ductwork shall be rigid board type. Insulation for round ductwork and concealed rectangular ductwork shall be blanket type.
- .3 Liberally apply adhesive to all surfaces of the ductwork and/or casing. Provide weld-on pins at 450 mm (18 in.) centres on the bottom duct surface only where blanket insulation is to be applied, and at 450 mm (18 in.) centres on bottom and side surfaces of ducts and/or casings where board insulation is to be applied. Secure the insulation in place with tight circumferential and longitudinal joints. Secure and seal all joints with 75 mm (3 in.) wide tape sealant. Install self-locking washers over pins and cut-off any excess pin length. Ensure that the insulation does not sag or bulge.
- .4 Provide drywall type metal corner beads on edges of exposed rectangular ductwork, casings and plenums in equipment rooms, service corridors, and any other area where the insulation is subject to accidental damage. Secure in place with tape sealant.
- .5 At each trapeze type duct hanger under rectangular or oval ductwork to be insulated with blanket type insulation, provide a 100 mm (4 in.) wide full length piece of rigid fibreglass board insulation between the duct and the hanger and cover joints with strips of tape sealant.
- .6 At each band type duct hanger around round ductwork to be insulated, provide a 100 mm (4 in.) wide section of sleeve or scored board type fibreglass insulation and cover joints with tape sealant.

### 3.11 DUCT WRAP REQUIREMENTS – FIRE RATED MATERIAL

- .1 Provide blanket type fire rated duct wrap system material at the locations listed below and where indicated on the Contract Drawings, the duct wrap shall produce the fire rating of the fire barrier that the duct is penetrating.
  - .1 Combustion air duct.
- .2 Install the duct wrap material in accordance with ULC design requirements and the wrap supplier's recommendations.
- .3 Coordinate installation of duct wrap with the installation of the ductwork specified in Section 23 30 00 – HVAC Ducts and Plenums.
- .4 Arrange and pay for the duct wrap supplier to examine the completed duct wrap system at the site. Submit a letter from the supplier to the Consultant to certify that the duct wrap system has been properly installed.

### 3.12 INSULATION FINISH REQUIREMENTS

- .1 White Sheet PVC: Unless otherwise shown and/or specified in the Contract Documents, jacket all exposed fibreglass insulation work inside the building with white sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal all joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by the manufacturer's instructions.
  - .1 Ductwork.
  - .2 Piping not listed under "Coloured Sheet PVC".
- .2 Coloured Sheet PVC: Unless otherwise shown and/or specified in the Contract Documents, jacket all exposed fibreglass insulation work inside the building with coloured sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal all joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by the manufacturer's instructions. Provide coloured sheet PVC and PVC fitting covers for the following insulation:
  - .1 Potable Water – Blue
  - .2 Non-Potable Water – Light Blue
  - .3 Tempered Potable Water – Blue
  - .4 Domestic Hot Water – Blue
  - .5 Storm Water – Grey
  - .6 Hot Water Heating – Orange
  - .7 Glycol Hot Water Heating – Yellow
  - .8 Chilled Water – Green
  - .9 Glycol Chilled Water – Light Green
- .3 Aluminum: Install aluminum jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket.
  - .1 Exterior Piping.
- .4 Stainless Steel: Install stainless steel jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket. Provide stainless steel jacket and fittings for the following:
  - .1 As an alternative to Aluminium jacketing.
- .5 Protective Coating - Foamed Glass Insulation: Apply two heavy coats of "PITTCOTE 404" coating to all foamed glass insulation exposed above grade.
- .6 Protective Coating – Flexible Elastomeric Insulation: Apply two heavy coats of the coating specified in the Contract Documents to all flexible elastomeric insulation exposed above grade.

**END OF SECTION**

1 General

1.1 REFERENCE STANDARDS

- .1 Institute of Electrical and Electronics Engineers (IEEE)
  - .1 IEEE 519-1992, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
- .2 National Electrical Manufacturer Association (NEMA)
  - .1 NEMA Standard 250, Electrical Enclosure Types – Non Hazardous Location Environmental Rating Standards.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit complete material, construction and performance shop drawings for variable frequency drives. Include the following:
  - .1 Drive performance data.
  - .2 Materials of construction.
  - .3 Size and weight of drive.
  - .4 BAS sequencing and control information.
  - .5 Electrical connection sizes and approximate locations.
  - .6 Operating and Maintenance Data.
  - .7 Start-up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements specified in Section 01 91 00 – Commissioning Specifications and Section 20 05 93 - Testing, Adjusting, and Balancing (TAB).

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 - Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 Products

2.1 VARIABLE FREQUENCY DRIVES (VFDS)

- .1 Variable Frequency Drives: provide variable frequency drives for all mechanical systems as shown in the Schedules and drawings.
- .2 HVAC / drive control wiring interface to be provided by Division 25. Each VFD shall be provided with BACnet compatible control interface. Provide points list and integration information to Division 25 as required.
- .3 Provide approved VFDs with horsepower ratings to match the fan motors as indicated on the drawing schedules and complete with features and characteristics as follows:
  - .1 All VFDs of 25 HP and lower shall be supplied complete with Hammond RM Series or MTE three phase input line reactors or approved equivalent, required to provide line transient voltage protection. A minimum of 5% is required.
  - .2 All VFD's of 30 hp and above shall be equipped with MIRUS International Inc. LINEATOR™ Universal Harmonic Filter (UHF), MTE Matrix Filter or approved

equivalent to reduce total harmonic current and voltage distortion to the limits specified by Standard IEEE 519 1992 at the input terminals of the harmonic filters. Input line reactors are not acceptable. A single Lineator is acceptable for use with both the supply and return fans.

- .3 The VFD shall be of the fully digital pulse width modulated (PWM) type utilizing insulated gate bipolar transistors (IGBT's) in the inverter section of the VFD. The VFD shall accept AC line voltage variation of +15%. No transformers shall be used on either the input or output of the VFD.
  - .4 Displacement Power Factor: 0.98 over entire range of operating speed and load.
  - .5 Minimum efficiency: 96%.
  - .6 Overload capacity: 120% for Variable Torque Application & 150% for 1 min. for Constant Torque Applications.
  - .7 All drive parameters (set up, operating and adjustment settings) to be entered via keypad, without tools. Three adjustable set-points to lock out continuous operation at frequencies which may produce mechanical resonance. Drive to be capable of determining the speed and direction of a spinning motor and adjusting its output to "pick-up" the motor at the rotating speed. The flying start feature is to be operable with, or without, encoder feedback.
  - .8 For indoor applications inside mechanical rooms, provide surface mounting NEMA 12 ventilated enclosure with hinged door and filter suitable for rack mounting, designed to provide electromagnetic shielding. Provide a Hand-Off-Auto switch on face of panel for control of VFD's as per control drawings.
  - .9 NEMA 12 ventilated enclosure or Open (Protected) Chassis VFD with keypad/display installed through the door of the VFD panel enclosure (accessible on outside face of door).
  - .10 For outdoor applications, provide NEMA 4x enclosures.
  - .11 Provide incoming, horsepower rated, disconnect switch with an operating mechanism.
  - .12 Provide input line fuses coordinated with the VFD's electronic protection circuits so as not to blow under normal output faults such as overcurrent, short circuit and ground fault.
  - .13 Provide output line reactors if the distance between the VFD and motor is greater than 15m and/ or as per manufacturer recommendation.
  - .14 If the HOA switch is in "Auto" the fan ramps up to its current assigned speed setting over an adjustable time period (up to 90 seconds). If the HOA switch is in "Hand" the fan ramps up to the minimum speed setting and is controlled thereafter from the VFD keypad display.
- .4 Protection:
- .1 Provide the VFD with internal protection features.
  - .2 Fault Sensing shall include but not be limited to:
    - .1 Power On
    - .2 Overload protection
    - .3 Overcurrent Protection
    - .4 Short Circuit Protection
    - .5 Inverter Fault

- .6 External Fault
- .7 Over Voltage
- .8 Under Voltage and Phase Loss
- .9 DC Bus Under-voltage/Over-voltage Protection
- .10 Over Temperature Protection
- .11 Power Semi-Conductor Protection
- .12 Ground Fault Protection
- .13 Heatsink Over-Temperature Protection
- .14 Output phase to phase & phase to ground short circuit protection
- .5 Environment:
  - .1 The VFD shall have the following minimum environmental tolerances:
    - .1 Ambient temperature range of 0°C to 40°C (32°F to 104°F).
    - .2 Units located in non-heated areas shall be provided with thermostatically controlled heated weather enclosure.
    - .3 Maximum humidity of 95% non-condensing.
    - .4 Maximum altitude of 1000m for rated output.
- .6 Performance:
  - .1 The VFD shall automatically restart after an inverter fault trip. The VFD shall attempt to restart automatically 5 times with Lock Out after the third attempt if a restart has not occurred.
  - .2 The VFD shall have automatic/manual signal follower for 4 20 mA or 0-10 VDC reference.
  - .3 All drive parameters (set up, operating and adjustment settings) to be entered via keypad without tools.
  - .4 "Ride through" of short power interruptions.
  - .5 Auto restart following fault, except for ground and short circuit faults. The drive shall shut down and annunciate any fault conditions (as a minimum) and display the appropriate fault code on the display of the keypad.
  - .6 Automatic/manual selection via (Hand/Off/Auto) switch. In manual or hand control, drive speed shall be controlled via the keypad. In automatic control drive speed shall be controlled via 4-20mA and/or a 0-10V DC signal from the BAS (BAS connections by others).
  - .7 In the event of loss of 4 - 20mA reference signal the drive should give an alarm and maintain last reference (within 10%).
  - .8 Inverter duty motors with insulated bearings, winding thermistors and suitable for operation from variable frequency drives.
  - .9 Refer to Division 20, 22, 23, 25 for wiring/circuits required to achieve functionality described in the HVAC control drawings, electrical drawings (where applicable) and specifications.
  - .10 In the Auto mode, the VFD shall modulate motor speeds as instructed by the BAS or other controls device (pushbutton, gas detector...etc).

- .11 Output signals to be monitored by BAS or other controls device via BACnet/IP integration module.
- .12 Provide thermistor operated relays.
- .13 Provide hardwire and communication interface and interlocks.
- .7 VFD cabinets are to be complete with door interlocked fused disconnect switch.
- .8 VFD supplier is to provide start up assistance and training to the Project Co. and Owner's staff.
- .9 Acceptable Manufactures:
  - .1 ABB
  - .2 Danfoss
  - .3 Yaskawa
  - .4 Toshiba
  - .5 Cutler Hammer

### 3 Execution

#### 3.1 INSTALLATION OF VARIABLE FREQUENCY DRIVES (VFDS)

- .1 Comply with manufacturer's installation instructions.
- .2 Coordinate VFD location with Division 26, provide additional disconnect switches if required by the authorities having jurisdiction. Disconnect switch shall be wired in series to avoid drive operation while the disconnection switch is open.
- .3 Locate and mount VFDs as shown on the Drawings.
- .4 Arrange for a manufacturer's technical representative:
  - .1 Inspect the installation of drives prior to start-up.
  - .2 Test and commission all drives.
- .5 Measure the distortion of each phase at the load terminals of the branch breaker and report the results in the commissioning report.
- .6 All VFDs shall be installed in a location that meets the environmental conditions.

**END OF SECTION**

1 General

1.1 **REFERENCE STANDARDS**

- .1 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S104, Standard Method for Fire Tests of Door Assemblies.
- .2 Ontario Building Code (OBC)

1.2 **DEFINITIONS**

- .1 For purposes of this Section:
  - .1 "CONCEALED" means mechanical services and equipment in suspended ceilings, non-accessible chases, and furred-in spaces.
  - .2 "EXPOSED" means "not concealed" as defined in this Section.

1.3 **SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
  - .1 Submit a set of shop drawings identifying size, type and location of all access doors, for review, before installation.
  - .2 Include manufacturer product literature and ULC certification.

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 60 00 - Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 Products

2.1 **ACCESS DOORS**

- .1 Masonry Wall Access Doors:
  - .1 Doors in masonry walls shall be complete with a 16 ga. prime painted steel door panel, rust resistant concealed hinges, flanged frame, and screwdriver operated lock.
  - .2 Acceptable Manufacturers:
    - .1 Acudor; Model UF 5000.
    - .2 Mifab; Model UA.
    - .3 William Brothers; Model WB-UAD.
- .2 Gypsum Board Partition or Ceiling Access Doors:
  - .1 Doors in drywall partitions or ceilings shall be complete with a 16 ga. prime painted steel recessed door panel for the acceptance of a drywall insert, concealed hinges, drywall bead frame, and screwdriver operated lock.
  - .2 Acceptable Manufacturers:
    - .1 Acudor; Model DW 5015.
    - .2 Mifab; Model CAD-DW.



- .3 William Brothers; Model WB-RDW.
- .3 Fire Rated Wall or Ceiling Access Doors:
  - .1 Access doors in fire rated walls or ceilings shall be ULC labeled and certified in accordance with UL 10(b) and CAN/ULC S104 for a minimum 1-1/2 hour rating (rating to increase as necessary to maintain the fire separation integrity). Doors shall be complete with insulated door panel, concealed hinge, self closing, self latching, flanged frame, and prime painted. Provide master key operated catch in areas accessible to the public.
  - .2 Acceptable Manufacturers:
    - .1 Acudor; Model FW 5050.
    - .2 Mifab; Model MPFR.
    - .3 William Brothers; Model WB-FR-S.
- .4 Tiled Wall or Ceiling Access Doors:
  - .1 Doors in tiled walls or ceilings shall be complete with a 16 ga. stainless steel door panel, type 304 with #4 satin finish, concealed hinges, wall frame and screw driver operated lock.
  - .2 Acceptable Manufacturers:
    - .1 Acudor; Model UF 5000.
    - .2 Mifab; Model UA-SS.
    - .3 William Brothers; Model WB-UAD-SS.
- .5 Medium and High Security Wall or Ceiling Access Doors:
  - .1 Doors for medium and high security applications in solid walls shall be 10 ga. steel door with minimum 4 mm (3/16 in.) welded angle frame with heavy duty butt hinges welded to the door and frame with master keyed cylinder in accordance with Section 08 71 00 Door Hardware.
  - .2 Acceptable Manufacturers:
    - .1 Acudor; Model SD 6000.
    - .2 Mifab; Model MI-SADH.
    - .3 William Brothers; Model WB-HS.
- .6 Minimum size of doors shall be:
  - .1 300 mm x 300 mm (12 in. x 12 in.) for hand access, wherever practicable. The access door shall be upsized as required to facilitate (and not impede) full accessibility; the access door size shall also accommodate for removal of the device.
  - .2 200 mm x 200 mm (8 in. x 8 in.) for valves and cleanouts. This door size is only permitted when installation of a 300 mm x 300 mm (12 in. x 12 in.) is not practicable. The access door shall be upsized as required to facilitate (and not impede) full accessibility; the access door size shall also accommodate for removal of the device.
  - .3 600 mm x 600 mm (24 in. x 24 in.) for body access.
  - .4 900 mm x 900 mm (36 in. x 36 in.) for access to penal fixture chases.

### 3 Execution

#### 3.1 INSTALLATION OF ACCESS DOORS

- .1 All parts of the installation requiring periodic maintenance shall be accessible. Wherever valves, dampers, motors, instruments, equipment, controllers, control panels and other appurtenances are concealed by building construction, access doors shall be furnished by this Section and installed under the respective Trade Sections (i.e. masonry, drywall, tile, etc.) This Section is responsible for the proper location of the access doors.
- .2 Wherever possible, items requiring access shall be located in easily accessible areas (i.e. exposed or T-bar ceilings).
- .3 Group items in order to minimize the number of access doors required.
- .4 Each access door shall be installed to provide complete access to equipment for maintenance and servicing.
- .5 The final installed locations of all access doors shall be shown on the As-Built and Record Drawings.

**END OF SECTION**

1 GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Two-piece ball valves with indicators.
- .2 Bronze butterfly valves with indicators.
- .3 Iron butterfly valves with indicators.
- .4 Check valves.
- .5 Bronze OS&Y gate valves.
- .6 Iron OS&Y gate valves.
- .7 NRS gate valves.
- .8 Indicator posts.
- .9 Trim and drain valves.

1.2 REFERENCE STANDARDS

.1 ASME

- .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
- .2 ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings
- .3 ASME B31.9 Building Services Piping

.2 AWWA

- .1 AWWA C606 Standard for Grooved and Shouldered

.3 NFPA

- .1 NFPA 13 Standard for the Installation of Sprinkler Systems
- .2 NFPA 14 Standard for the Installation of Standpipe and Hose
- .3 NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
- .4 NFPA 24 Standard for the Installation of Private Fire Service Mains and their Appurtenances.
- .5 ULC listed and/ or FM approved
- .6 National Building Code
- .7 National Fire Code

1.3 DEFINITIONS

- .1 NRS: Nonrising stem.
- .2 OS&Y: Outside screw and yoke.
- .3 SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Prepare valves for shipping as follows:
  - .1 Protect internal parts against rust and corrosion.
  - .2 Protect threads, flange faces, and weld ends.
  - .3 Set valves open to minimize exposure of functional surfaces.
- .2 Use the following precautions during storage:
  - .1 Maintain valve end protection.
  - .2 Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- .3 Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- .4 Protect flanges and specialties from moisture and dirt.

## 2 PRODUCTS

### 2.1 SOURCE LIMITATIONS

- .1 Obtain each type of valve from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- .1 ULC listed and/ or FM approved
  - .1 Fire Main Equipment: HAMV - Main Level
    - .1 Indicator Posts, Gate Valve: HCBZ - Level 1
    - .2 Ball Valves, System Control: HLUG - Level 3
    - .3 Butterfly Valves: HLXS - Level 3
    - .4 Check Valves: HMER - Level 3
    - .5 Gate Valves: HMRZ - Level 3
  - .2 Sprinkler System & Water Spray System Devices: VDGT - Main Level
    - .1 Valves, Trim and Drain: VQGU - Level 1
- .2 ULC listed and/ or FM approved
  - .1 Automated Sprinkler Systems:
    - .1 Indicator posts.
    - .2 Valves.
      - .1 Gate valves.
      - .2 Check valves
      - .3 Miscellaneous valves.
- .3 ASME Compliance:
  - .1 ASME B1.20.1 for threads for threaded-end valves.
  - .2 ASME B16.1 for flanges on iron valves.
  - .3 ASME B31.9 for building services piping valves.
- .4 AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

- .5 NFPA Compliance for valves:
  - .1 Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.
- .6 Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.
- .7 Valve Sizes: Same as upstream piping unless otherwise indicated.
- .8 Valve Actuator Types:
  - .1 Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
  - .2 Handwheel: For other than quarter-turn trim and drain valves.
  - .3 Handlever: For quarter-turn trim and drain valves DN 50 (NPS 2) and smaller.

## 2.3 TWO-PIECE BALL VALVES WITH INDICATORS

- .1 Description:
  - .1 ULC listed and/ or FM approved
  - .2 Minimum Pressure Rating: 1200 kPa (175 psig).
  - .3 Body Design: Two piece.
  - .4 Body Material: Forged brass or bronze.
  - .5 Port Size: Full or standard.
  - .6 Seats: PTFE.
  - .7 Stem: Bronze or stainless steel.
  - .8 Ball: Chrome-plated brass.
  - .9 Actuator: Worm gear
  - .10 Supervisory Switch: Internal or external.
  - .11 End Connections for Valves Dn 25 (NPS 1) through DN50 (NPS 2): Threaded ends.
  - .12 End Connections for Valves DN 65 (NPS 2-1/2): Grooved ends.

## 2.4 BRONZE BUTTERFLY VALVES WITH INDICATORS

- .1 Description:
  - .1 ULC listed and/ or FM approved
  - .2 Minimum: Pressure rating: 1200 kPa (175 psig).
  - .3 Body Material: Bronze.
  - .4 Seat Material: EPDM.
  - .5 Stem Material: Bronze or stainless steel.
  - .6 Disc: Stainless steel with EPDM coating.
  - .7 Actuator: Worm gear.
  - .8 Supervisory Switch: Internal or external.
  - .9 Ends Connections for Valves DN 25 (NPS 1) through DN 50 (NPS 2): Threaded ends.
  - .10 Ends Connections for Valves DN 65 (NPS 2-1/2): Grooved ends.

## 2.5 IRON BUTTERFLY VALVES WITH INDICATORS

### .1 Description:

- .1 ULC listed and/ or FM approved
- .2 Minimum Pressure Rating: 1200 kPa (175 psig).
- .3 Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
- .4 Seat Material: EPDM.
- .5 Stem: Stainless steel.
- .6 Disc: Ductile iron, nickel plated and EPDM or SBR coated.
- .7 Actuator: Worm gear.
- .8 Supervisory Switch: Internal or external.
- .9 Body Design: Grooved-end connections.

## 2.6 CHECK VALVES

### .1 Description:

- .1 ULC listed and/ or FM approved
- .2 Minimum Pressure Rating: 1200 kPa (175 psig).
- .3 Type: Single swing check.
- .4 Body Material: Cast iron, ductile iron, or bronze.
- .5 Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
- .6 Clapper Seat: Brass, bronze, or stainless steel.
- .7 Hinge Shaft: Bronze or stainless steel.
- .8 Hinge Spring: Stainless steel.
- .9 End Connections: Flanged, grooved, or threaded.

## 2.7 BRONZE OS&Y GATE VALVES

### .1 Description:

- .1 ULC listed and/ or FM approved
- .2 Minimum Pressure Rating: 1200 kPa (175 psig).
- .3 Body and Bonnet Material: Bronze or brass.
- .4 Wedge: One-piece bronze or brass.
- .5 Wedge Seat: Bronze.
- .6 Stem: Bronze or brass.
- .7 Packing: Non-asbestos PTFE.
- .8 Supervisory Switch: External.
- .9 End Connections: Threaded.

## 2.8 IRON OS&Y GATE VALVES

### .1 Description:

- .1 ULC listed and/ or FM approved

- .2 Minimum Pressure Rating: 1200 kPa (175 psig).
- .3 Body and Bonnet Material: Cast or ductile iron.
- .4 Wedge: Cast or ductile iron, or bronze with elastomeric coating.
- .5 Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
- .6 Stem: Brass or bronze.
- .7 Packing: Non-asbestos PTFE.
- .8 Supervisory Switch: External.
- .9 End Connections: Threaded.

## 2.9 NRS GATE VALVES

- .1 Description:
  - .1 ULC listed and/ or FM approved
  - .2 Minimum Pressure Rating: 1200 kPa (175 psig).
  - .3 Body and Bonnet Material: Cast or ductile iron.
  - .4 Wedge: Cast or ductile iron[ with elastomeric coating.
  - .5 Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
  - .6 Stem: Brass or bronze.
  - .7 Packing: Non-asbestos PTFE.
  - .8 Supervisory Switch: External.
  - .9 End Connections: Flanged.

## 2.10 INDICATOR POSTS

- .1 Description:
  - .1 ULC listed and/ or FM approved
  - .2 Type: Underground.
  - .3 Base Barrel Material: Cast or ductile iron.
  - .4 Extension Barrel: Cast or ductile iron.
  - .5 Cap: Cast or ductile iron.
  - .6 Operation: Wrench

## 2.11 TRIM AND DRAIN VALVES

- .1 Ball Valves:
  - .1 Description:
    - .1 Pressure Rating: 1200 kPa (175 psig).
    - .2 Body Design: Two piece.
    - .3 Body Material: Forged brass or bronze.
    - .4 Port size: Full or standard.
    - .5 Seats: PTFE.
    - .6 Stem: Bronze or stainless steel.

- .7 Ball: Chrome-plated brass.
- .8 Actuator: Handlever.
- .9 End Connections for Valves DN 25 (NPS 1) through DN 65 (NPS 2-1/2): Threaded ends.
- .10 End Connections for Valves DN 32 and DN 65 (NPS 1-1/4 and NPS 2-1/2): Grooved ends.
- .2 Angle Valves:
  - .1 Description:
    - .1 Pressure Rating: 1200 kPa (175 psig).
    - .2 Body Material: Brass or bronze.
    - .3 Ends: Threaded.
    - .4 Stem: Bronze.
    - .5 Disc: Bronze.
    - .6 Packing: Asbestos free.
    - .7 Handwheel: Malleable iron, bronze, or aluminum.
- .3 Globe Valves:
  - .1 Description:
    - .1 Pressure Rating: 1200 kPa (175 psig)
    - .2 Body Material: Bronze with integral seat and screw-in bonnet.
    - .3 Ends: Threaded.
    - .4 Stem: Bronze.
    - .5 Disc Holder and Nut: Bronze.
    - .6 Disc Seat: Nitrile.
    - .7 Packing: Asbestos free.
    - .8 Handwheel: Malleable iron, bronze, or aluminum.

### 3 EXECUTION

#### 3.1 EXAMINATION

- .1 Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- .2 Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- .3 Examine threads on valve and mating pipe for form and cleanliness.
- .4 Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- .5 Do not attempt to repair defective valves; replace with new valves.

#### 3.2 INSTALLATION, GENERAL



- .1 Comply with requirements in the following Sections for specific valve-installation requirements and applications:
  - .1 Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
  - .2 Section 211316 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.
- .2 Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.
- .3 Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- .4 Install valves in horizontal piping with stem at or above the pipe center.
- .5 Install valves in position to allow full stem movement.
- .6 Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

**END OF SECTION**

1 General

1.1 **SUMMARY**

.1 Section Includes:

- .1 Exposed-type fire-department connections.
- .2 Flush-type fire-department connections.
- .3 Yard-type fire-department connections.

1.2 **REFERENCE STANDARDS**

- .1 Underwriters Laboratory (UL)

1.3 **ACTION SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: For each type of product.
  - .1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

2 Products

2.1 **EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION**

- .1 Standard: UL 405.
- .2 Type: Exposed, projecting, for wall mounting.
- .3 Pressure Rating: 1200-kPa (175-psig) minimum.
- .4 Body Material: Corrosion-resistant metal.
- .5 Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- .6 Caps: Brass, lugged type, with gasket and chain.
- .7 Escutcheon Plate: Round, brass, wall type.
- .8 Outlet: Back, with pipe threads.
- .9 Number of Inlets: Two.
- .10 Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE"
- .11 Finish: Polished chrome plated.
- .12 Outlet Size: DN 100 (NPS 4).

2.2 **FLUSH-TYPE FIRE-DEPARTMENT CONNECTION**

- .1 Standard: UL 405.
- .2 Type: Flush, for wall mounting.
- .3 Pressure Rating: 1200-kPa (175-psig) minimum.
- .4 Body Material: Corrosion-resistant metal.
- .5 Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

- .6 Caps: Brass, lugged type, with gasket and chain.
- .7 Escutcheon Plate: Rectangular, brass, wall type.
- .8 Outlet: With pipe threads.
- .9 Body Style: Horizontal.
- .10 Number of Inlets: Three.
- .11 Outlet Location: Bottom .
- .12 Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- .13 Finish: Polished chrome plated.
- .14 Outlet Size: DN 100 ([NPS 4).

### 2.3 YARD-TYPE-DEPARTMENT CONNECTION

- .1 Standard: UL 405.
- .2 Type: Exposed, freestanding.
- .3 Pressure Rating: 1200-kPa (175 psig) minimum.
- .4 Body Material: Corrosion-resistant metal.
- .5 Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- .6 Caps: Brass, lugged type, with gasket and chain.
- .7 Escutcheon Plate: Round, brass, floor type.
- .8 Outlet: Bottom, with pipe threads.
- .9 Number of Inlets: Three.
- .10 Sleeve: Brass.
- .11 Sleeve Height: 460 mm (18 inches).
- .12 Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- .13 Finish, Including Sleeve: Polished chrome plated
- .14 Outlet Size: DN 100 (NPS 4).

## 3 Execution

### 3.1 EXAMINATION

- .1 Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- .2 Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- .1 Install wall-type fire-department connections.
- .2 Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 - Cast-in-Place Concrete.

- .3 Install two protective pipe bollards on sides of each fire-department connection. Comply with requirements for bollards in Section 05 50 00 - Metal Fabrications.
- .4 Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

**END OF SECTION**

1 GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Pipes, fittings, and specialties.
- .2 Cover system for sprinkler piping.
- .3 Specialty valves.
- .4 Sprinklers.
- .5 Alarm devices.
- .6 Manual control stations.
- .7 Control panels.
- .8 Pressure gauges.

1.2 REFERENCE STANDARDS

.1 ANSI

- .1 ANSI/ASA S3.41 Audible Emergency Evacuation (E2) and Evacuation Signals with Relocation Instructions (ESRI)

.2 ASME

- .1 2010 ASME Boiler and Pressure Vessel Code
- .2 ASME B1.20.1 Pipe Threads, General Purpose, Inch
- .3 ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings
- .4 ASME B16.4 Cast Iron Threaded Fittings
- .5 ASME B16.5 Pipe Flanges and Flanged Fittings
- .6 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
- .7 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- .8 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings
- .9 ASME B31.9 Building Services Piping
- .10 ASME B36.10M Welded and Seamless Wrought Steel Pipe

.3 ASTM

- .1 ASTM A47/A47M Standard Specification for Ferritic Malleable Iron Castings
- .2 ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- .3 ASTM A135/A135M Standard Specification for Electric-Resistance-Welded Steel Pipe
- .4 ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- .5 ASTM A536 Standard Specification for Ductile Iron Castings
- .6 ASTM A733 Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

- .7 ASTM A795/A795M Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
- .8 ASTM A865/A865M Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints
- .9 ASTM B75/B75M Standard Specification for Seamless Copper Tube
- .10 ASTM B88 Standard Specification for Seamless Copper Water Tube
- .11 ASTM B584 Standard Specification for Copper Alloy Sand Castings for General Applications
- .12 ASTM F2014 Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications.
- .13 ASTM F438 Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
- .14 ASTM F439 Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- .15 ASTM F402 Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
- .16 ASTM F442/F442M Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
- .17 ASTM F493 Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
- .18 ASTM F2014 Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications
- .19 ASTM D2846/D2846M Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
- .4 AWS
  - .1 AWS A5.8M/A5.8 Specification For Filler Metals For Brazing And Braze Welding
  - .2 AWS D10.12M/D10.12 Guide For Welding Mild Steel Pipe-American Welding Society
- .5 AWWA
  - .1 AWWA C606 Standard for Grooved and Shouldered Joints
  - .2 AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings
- .6 CSA
  - .1 CSA Z245.30 – Field-applied external coatings for steel pipeline systems.
- .7 ISO
  - .1 ISO 8201 Alarm systems — Audible emergency evacuation signal — Requirements
- .8 MSS
  - .1 MSS SP-123 Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube
- .9 NFPA
  - .1 NFPA 13 Standard for the Installation of Sprinkler Systems
  - .2 NFPA 13R Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies

- .3 NFPA 70 National Electrical Code
- .4 NFPA 291 NFPA 291 Recommended Practice for Fire Flow Testing and Marking of Hydrants
- .10 ULC listed and/ or FM approved
- .11 National Building Code
- .12 National Fire Code
- .13 AN/ULC-S524 (Standard for the Installation of Fire Alarm Systems)
- .14 CAN/ULC-S537 (Standard for the Verification of Fire Alarm Systems)

### 1.3 DEFINITIONS

- .1 High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 1200-Kpa (175 psig), but not higher than 1725-kPa (250 psig).
- .2 Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 1200-kPa (175-psig) maximum.

### 1.4 ACTION SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: For each type of product.
- .3 Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- .4 Sustainable Design Submittals:
- .5 Shop Drawings: For wet-pipe sprinkler systems.
  - .1 Include plans, elevations, sections, and attachment details.
  - .2 Include diagrams for power, signal, and control wiring.
- .6 Retain Professional Engineer, licensed in the Province of Ontario, with experience in Work of comparable complexity and scope, to perform the following services as part of the Work of this Section:
  - .1 Design of system and sizing calculations.
  - .2 Review, stamp, and sign shop drawings and design calculations.
  - .3 Monitor and report on manufacturer's quality control tests and reports for compliance with Contract Documents.
- .7 Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer, licensed in the Province of Ontario, responsible for their preparation.
- .8 Regulatory requirements:
  - .1 Prior to purchase and installation of sprinkler system, submit documents to authority having jurisdiction and obtain their approval.
  - .2 Make submissions to authority having jurisdiction well in advance so as not to delay installation.

### 1.5 INFORMATIONAL SUBMITTALS

- .1 Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - .1 Domestic water piping.
  - .2 Compressed air piping.
  - .3 HVAC hydronic piping.
  - .4 Items penetrating finished ceiling include the following:
    - .5 Lighting fixtures.
    - .6 Air outlets and inlets.
    - .7 All electrical.
- .2 Qualification Data: For qualified Installer and Professional Engineer.
- .3 Design Data:
  - .1 Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- .4 Seismic Qualification Data:
  - .1 Post disaster facility
- .5 Welding certificates.
- .6 Field Test Reports:
  - .1 Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
  - .2 Fire-hydrant flow test report.
- .7 Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - .1 Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

#### 1.8 QUALITY ASSURANCE

- .1 Installer Qualifications:
  - .1 Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
    - .1 Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified Professional Engineer.
  - .2 Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.



## 1.9 FIELD CONDITIONS

- .1 Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
  - .1 Notify Construction Contractor no fewer than two days in advance of proposed interruption of sprinkler service.
  - .2 Do not proceed with interruption of sprinkler service without Construction Manager's/Owner's written permission.

## 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- .1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .2 Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.
- .3 Standard-Pressure Piping System Component: Listed for 1200-kPa (175-psig) minimum working pressure.
- .4 High-Pressure Piping System Component: Listed for 1725-kPa (250-psig) minimum working pressure.
- .5 Delegated Design: Engage a qualified Professional Engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
  - .1 Sprinkler system design shall be approved by authorities having jurisdiction.
    - .1 Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
  - .2 Maximum Protection Area per Sprinkler:
    - .1 In according to NFPA 13 recommendations unless otherwise indicated.
- .6 Seismic Performance: See Section 20 05 50 – Seismic Restraint System.

### 2.2 STEEL PIPE AND FITTINGS

- .1 PVC: Ipex "Brute Brute " Class 200, DR14, rigid, hub and spigot pattern PVC pipe and CSA certified fittings to CSA B137.2 and B137.3, ULC listed and FM approved and complete with gasketed joints.
- .2 Stainless Steel – Welded Joint: Type 304/316 Schedule 40, ASTM 312, mill or site beveled, complete with factory made seamless stainless steel, butt welding fittings to ASTM A403M & ASME B16.9, long sweep pattern wherever possible, and welded joints. For underground applications piping shall be wrapped in one of the following corrosion-resistant systems:
  - .1 PVC Pipe Tape: Minimum 0.25 mm (10 mil) thick, suitable for direct burial, and provide resistance from corrosion by means of water (moisture), salts, alkalis, dielectric contact, and soil acids. Wrap system shall also resist growth of bacteria/fungus, abrasion, and UV (sunlight).
  - .2 Petrolatum Based Wrap: Product shall be suitable for direct burial and consist of petrolatum based tape, primer, and mastic (where contouring is necessary). Wrap system shall be designed to provide long term corrosion protection, and will not crack, peel, or harden over time. Product shall remain impermeable to moisture after burial and/or submersion in water. System shall be certified to CSA Z245.30.

- .3 Schedule 40 Steel - Grooved Coupling Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with mill or site roll grooved ends, and Victaulic "Fire Lock" or "FIT Style 960 fittings", Gruvlok Fig. #7105 "Sock-It" fittings, Tyco Fire Suppression & Building Products Mechanical Outlet Tee Fig. 730 and Victaulic Style 005, Tyco Fire Suppression & Building Products #772, Gruvlok Rigid-Lite #7400, Shurjoint "Speed" or "Z05" rigid coupling joints or approved equivalent. Snap-Let type or strap type fittings are not acceptable.
- .4 Schedule 40 Steel - Screwed and Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping is to be complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping is to be complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.
- .5 Schedule 10 Steel - Grooved Coupling Joints: Schedule 10 mild black carbon steel, ASTM A53, Grade B, or ASTM A795, Grade A, complete with mill or site roll grooved ends, and Victaulic "Fire Lock" fittings, Tyco Fire Suppression & Building Products grooved fittings and Victaulic Style 005, Tyco Fire Suppression & Building Products #772, Gruvlok Rigid-Lite #7400 rigid coupling joints or approved equivalent. Snap-Let type or strap type fittings are not acceptable.

## 2.3 SERVICE MAIN REDUCED PRESURE ZONE DETECTOR ASSEMBLY

- .1 Minimum 2005 kPa (175 psi) rated, ULC listed and FM approved reduced pressure zone backflow preventer assembly (with shut-off valves) to CAN/CSA B64, complete with test cocks, and piping by-pass assembly with water meter. Acceptable products are:
  - .1 Watts Series 957 RPDA
  - .2 Zurn/Wilkins 375DA Series

## 2.4 COVER SYSTEM FOR SPRINKLER PIPING

- .1 Description: System of support brackets and covers made to protect sprinkler piping.
- .2 Brackets: Glass-reinforced nylon.

## 2.5 SPECIALTY VALVES

- .1 ULC listed and/ or FM approved
- .2 Pressure Rating:
  - .1 Standard-Pressure Piping Specialty Valves: 1200-kPa (175-psig) minimum.
  - .2 High-Pressure Piping Specialty Valves: 1725-kPa (250-psig) minimum.
- .3 Body Material: Cast or ductile iron.
- .4 Size: Same as connected piping.
- .5 End Connections: Flanged or grooved.
- .6 Alarm Valves:
  - .1 ULc listed and/ or FM approved
  - .2 Design: For horizontal or vertical installation.
  - .3 Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
  - .4 Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
  - .5 Drip Cup Assembly: Pipe drain with check valve to main drain piping.

- .6 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - .7 Deluge Valves:
    - .1 ULc listed and/ or FM approved
    - .2 Design: Hydraulically operated, differential-pressure type.
    - .3 Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
    - .4 Wet, Pilot-Line Trim Set: Include gage to read diaphragm-chamber pressure and manual control station for manual operation of deluge valve, and connection for actuation device.
  - .8 Automatic (Ball Drip) Drain Valves:
    - .1 ULc listed and/ or FM approved
    - .2 Pressure Rating: 1200-kPa (175-psig) minimum.
    - .3 Type: Automatic draining, ball check.
    - .4 Size: DN 20 (NPS 3/4).
    - .5 End Connections: Threaded.
- 2.6 **AIR VENT**
- .1 Manual Air Vent/Valve:
    - .1 Description: Ball valve that requires human intervention to vent air.
    - .2 Body: Forged brass.
    - .3 Ends: Threaded.
    - .4 Minimize Size: 13 mm (1/2 inch).
    - .5 Minimum Water Working Pressure Rating: 2070-kPa (300 psig).
  - .2 Automatic Air Vent:
    - .1 Description: Automatic air vent that automatically vents trapped air without human intervention.
    - .2 Standard: ULc listed or FM Global approved for use in wet-pipe fire sprinkler systems.
    - .3 Vents oxygen continuously from system.
    - .4 Float valve to prevent water discharge.
    - .5 Minimum Water Working Pressure Rating: 1207-kPa (175-psig).
  - .3 Automatic Air Vent Assembly:
    - .1 Description: Automatic air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly.
    - .2 Standard: ULc listed or FM Global approved for use in wet-pipe fire sprinkler system.
    - .3 Vents oxygen continuously from system.
    - .4 Float valve to prevent water discharge.
    - .5 Minimum Water Working Pressure Rating: 1207-kPa (175-psig).

## 2.7 SPRINKLER PIPING SPECIALTIES

- .1 Branch Outlet Fittings:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1200-kPa (175-psig) minimum.
  - .3 Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  - .4 Type: Mechanical-tee and -cross fittings.
  - .5 Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
  - .6 Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
  - .7 Branch Outlets: Grooved, plain-end pipe, or threaded.
- .2 Flow Detection and Test Assemblies:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1200-kPa (175-psig) minimum.
  - .3 Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
  - .4 Size: Same as connected piping.
  - .5 Inlet and Outlet: Threaded or grooved.
- .3 Branch Line Testers:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 175 psig (1200 kPa).
  - .3 Body Material: Brass.
  - .4 Size: Same as connected piping.
  - .5 Inlet: Threaded.
  - .6 Drain Outlet: Threaded and capped.
  - .7 Branch Outlet: Threaded, for sprinkler.
- .4 Sprinkler Inspector's Test Fittings:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1200-kPa (175-psig) minimum.
  - .3 Body Material: Cast- or ductile-iron housing with sight glass.
  - .4 Size: Same as connected piping.
  - .5 Inlet and Outlet: Threaded.
- .5 Adjustable Drop Nipples:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1725-kPa (250-psig) minimum.
  - .3 Body Material: Steel pipe with EPDM-rubber O-ring seals.
  - .4 Size: Same as connected piping.
  - .5 Length: Adjustable.
  - .6 Inlet and Outlet: Threaded.

- .6 Flexible Sprinkler Hose Fittings:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
  - .3 Pressure Rating: 1200-kPa ([175-psig) minimum.
  - .4 Size: Same as connected piping, for sprinkler.

## 2.8 SPRINKLERS

- .1 ULc listed and/ or FM approved
- .2 Pressure Rating for Residential Sprinklers: 175-psig (1200-kPa) maximum.
- .3 Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.
- .4 Pressure Rating for High-Pressure Automatic Sprinklers: 1725-kPa (250-psig) minimum.
- .5 Automatic Sprinklers with Heat-Responsive Element:
  - .1 ULc listed and/ or FM approved
  - .2 Characteristics: Nominal 12.7-mm (1/2-inch) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- .6 Open Sprinklers with Heat-Responsive Element Removed:
  - .1 Nominal Orifice: 12.7-mm (1/2 inch), with discharge coefficient K 5.3.
  - .2 Nominal Orifice: 13.5-mm (17/32 inch) with discharge coefficient K 7.4.
- .7 Sprinkler Finishes:
  - .1 Pendent: Chrome plated.
  - .2 Upright: Brass body.
- .8 Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  - .1 Ceiling Mounting: Chrome-plated steel, two piece, with 25-mm (1-inch) vertical adjustment or as required
  - .2 Sidewall Mounting: Chrome-plated steel, one piece, flat or as required.
- .9 Sprinkler Guards:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Wire cage with fastening device for attaching to sprinkler.

## 2.9 ALARM DEVICES

- .1 Alarm-device types shall match piping and equipment connections.
- .2 Water-Motor-Operated Alarm:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Mechanically operated, with Pelton wheel.
  - .3 Alarm Gong: Cast aluminum with red-enamel factory finish.
  - .4 Size: 216-mm (8-1/2-inches) diameter.
  - .5 Components: Shaft length, bearings, and sleeve to suit wall construction.

- .6 Inlet: DN 20 (NPS 3/4).
- .7 Outlet: DN 25 (NPS 1) drain connection.
- .3 Electrically Operated Notification Appliances:
  - .1 Electric Bell:
    - .1 ULc listed and/ or FM approved
    - .2 Type: Vibrating, metal alarm bell.
    - .3 Size: 150-mm (6-inch) minimum diameter.
    - .4 Voltage: 120 V ac, 60 Hz, 1 phase.
    - .5 Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
  - .2 Strobe/Horn:
    - .1 ULc listed and/ or FM approved
    - .2 Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
    - .3 Voltage: 120 V ac, 60 Hz.
    - .4 Effective Intensity: 110 cd.
    - .5 Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
    - .6 Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police, or fire department.
- .4 Water-Flow Indicators:
  - .1 ULc listed and/ or FM approved
  - .2 Water-Flow Detector: Electrically supervised.
  - .3 Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
  - .4 Type: Paddle operated.
  - .5 Pressure Rating: 1725-kPa (250-psig).
  - .6 Design Installation: Horizontal or vertical.
- .5 Pressure Switches:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Electrically supervised water-flow switch with retard feature.
  - .3 Components: Single-pole, double-throw switch with normally closed contacts.
  - .4 Design Operation: Rising pressure signals water flow.
- .6 Valve Supervisory Switches:
  - .1 ULc listed and/ or FM approved.

- .2 Type: Electrically supervised.
- .3 Components: Single-pole, double-throw switch with normally closed contacts.
- .4 Design: Signals that controlled valve is in other than fully open position.
- .5 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.10 MANUAL CONTROL STATIONS

- .1 ULc listed and/ or FM approved for hydraulic operation, with union, DN 15 (NPS 1/2) pipe nipple, and bronze ball valve.
- .2 Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.11 CONTROL PANELS

- .1 Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
  - .1 ULc listed and/ or FM approved when used with thermal detectors and Class A detector circuit wiring.
  - .2 Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
  - .3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .2 Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- .3 Manual Control Stations: Hydraulic operation, with union, DN 15 (NPS 1/2) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
  - .1 Panels Components:
  - .2 Power supply.
  - .3 Battery charger.
  - .4 Standby batteries.
  - .5 Field-wiring terminal strip.
  - .6 Electrically supervised solenoid valves and polarized fire-alarm bell.
  - .7 Lamp test facility.
  - .8 Single-pole, double-throw auxiliary alarm contacts.
  - .9 Rectifier.

## 2.12 PRESSURE GAUGES

- .1 ULc listed and/ or FM approved
- .2 Dial Size: 90-to-115-mm (3-1/2- to 4-1/2-inch) diameter.
- .3 Pressure Gauge Range: 0-to-1725-kPa (0- to 250-psig) minimum.
- .4 Label: Include "WATER" label on dial face.

## 2.13 FIRE BLANKETS

- .1 Equal to National Fire Equipment Ltd. Model #FB-6078 "BATTLEBLAZE" 1500 mm x 2000 mm (60" x 78") non-combustible glass fibre fire blanket with straps and a Model #FB-6078-MC flush wall mounting storage cabinet with identified face.

## 3 EXECUTION

### 3.1 PREPARATION

- .1 Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- .2 Report test results promptly and in writing.

### 3.2 SERVICE-ENTRANCE PIPING

- .1 All underground fire suppression piping outside the building footprint (from the outside of the foundation wall to the property line) shall be covered by the civil discipline.
- .2 Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in this section.

### 3.3 PIPING INSTALLATION

- .1 Pipe, unless otherwise specified, is to be as follows:
  - .1 For underground pipe inside the building Ipex "Blue Brute" Class 200, DR14 rigid PVC, braced and secured at bends and tees with concrete blocks in accordance with Municipal standards and details, and complete with No. 14 gge solid copper plastic insulated wire secured to the top of the pipe for the entire length of the pipe fastened with plastic type ties for pipe location tracing purposes. Lay pipes true to line and grade with bells up grade. Fit sections together so that, when complete, the pipe has a smooth and uniform invert. Keep pipe thoroughly clean so that jointed compound will adhere. Inspect the pipe for defects before being lowered into the trench. Do not use defective pipe. All non-ferrous piping shall be changed to ferrous piping prior to entering the building using an EBAA iron Inc. Mega-Coupling Series 3800 or equivalent. (i.e., changed before passing through basement floor or slab on grade).
  - .2 For piping inside building and above ground from service connection to discharge side of alarm valve, etc. - Schedule 40 grooved end black steel with Victaulic fittings and coupling joints, or, for piping to and including 50 mm (2 inch) diameter, screwed fittings and joints or piping 65 mm (2-1/2 inch) diameter and larger, welding fittings and welded joints.
  - .3 For pipe inside building and above ground to exterior pump test hose valve header and for fire department connection - Schedule 40 black steel as above.
  - .4 For piping downstream of "head end" alarm valve(s) and equipment – Schedule 10 black steel pipe with Victaulic fittings and coupling joints or Schedule 40 black steel with screwed fittings and joints.
  - .5 Galvanized for Dry Piping and Pre-Action System Piping.
- .2 Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
  - .1 Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
  - .2 Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.



- .3 Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- .4 Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- .5 Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- .6 Install unions adjacent to each valve in pipes DN 50 (NPS 2) and smaller.
- .7 Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.
- .8 Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- .9 Install sprinkler piping with drains for complete system drainage.
- .10 Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- .11 Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- .12 Install alarm devices in piping systems.
- .13 Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 20 05 50 – Seismic Restraint System.
- .14 Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than DN 8 (NPS 1/4) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- .15 Pressurize and check preaction sprinkler system piping.
- .16 Fill sprinkler system piping with water.
- .17 Install pipe insulation on wet-type fire-suppression standpipe piping in areas subject to freezing. Section 20 07 00 – Mechanical Insulation.
- .18 Install sleeves for piping penetrations of walls, ceilings, and floors.
- .19 Install sleeve seals for piping penetrations of concrete walls and slabs.
- .20 Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.4 JOINT CONSTRUCTION

- .1 Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- .2 Install unions adjacent to each valve in pipes DN 50 (NPS 2) and smaller.
- .3 Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.
- .4 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- .5 Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- .6 Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

- .7 Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
- .8 Apply appropriate tape or thread compound to external pipe threads.
- .9 Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- .10 Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- .11 Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- .12 Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- .13 Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- .14 Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- .15 Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- .16 Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- .17 Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.5 **INSTALLATION OF REDUCED PRESURE ZONE DETECTOR ASSEMBLY**

- .1 Provide a detector check valve with water meter and connecting piping inside the detector check valve assembly enclosure where shown. Confirm exact location prior to installation.
- .2 Equip the assembly with inlet and outlet supervised shut-off valves.
- .3 Support each end of the assembly from the floor by means of a flanged pipe support with saddles.
- .4 Connect electrical and control wiring as per electrical drawings.

### 3.6 **INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING**

- .1 Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

### 3.7 **VALVE AND SPECIALTIES INSTALLATION**

- .1 Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- .2 Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- .3 Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- .4 Specialty Valves:

- .1 Install valves in vertical position for proper direction of flow, in main supply to system.
- .2 Install alarm valves with bypass check valve and retarding chamber drain-line connection.
- .3 Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
- .5 Air Vent:
  - .1 Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
  - .2 Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
  - .3 Pipe from outlet of air vent to drain

### 3.8 SPRINKLER INSTALLATION

- .1 Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- .2 Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- .3 Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

### 3.9 IDENTIFICATION

- .1 Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- .2 Identify system components, wiring, cabling, and terminals. Follow the same identification requirements as those specified for the Fire Alarm System.

### 3.10 FIELD QUALITY CONTROL

- .1 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - .1 Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
  - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - .3 Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - .4 Energize circuits to electrical equipment and devices.
  - .5 Coordinate with fire-alarm tests. Operate as required.
  - .6 Coordinate with fire-pump tests. Operate as required.
  - .7 Verify that equipment hose threads are same as local fire department equipment.
- .2 Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- .3 Prepare test and inspection reports.

### 3.11 CLEANING

- .1 Clean dirt and debris from sprinklers.

- .2 Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

### 3.12 FIELD PAINTING

- .1 Clean, pretreat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.
- .2 Apply coatings to clean, dry surfaces, using clean brushes.
- .3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.
- .4 Immediately after cleaning, provide metal surfaces with 1 coat of pretreatment primer applied to minimum dry film thickness of 0.3 ml, and one coat of zinc chromate primer applied to minimum dry film thickness of 1.0 ml.
- .5 Shield sprinkler heads with protective covering while painting is in progress.
- .6 Upon completion of painting, remove protective covering from sprinkler heads.
- .7 Remove sprinkler heads which have been painted and replace with new sprinkler heads.
- .8 Provide primed surfaces, piping, valves and operating accessories with two coats of paint to match adjacent surfaces, finish with 2 coats of colour (refer to Owner requirements for colour code/ chart) alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil each.
- .9 Refer to 20 05 00 – General Mechanical Requirements and to Architectural Division for painting requirements prior to finalizing painting plan.

### 3.13 DEMONSTRATION

- .1 Engage a factory-authorized service representative to train Project Co and Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

### 3.14 SPRINKLER SCHEDULE

- .1 Use sprinkler types in subparagraphs below for the following applications:
  - .1 Quick response sprinklers shall be utilized throughout the project, unless otherwise required by NFPA 13 Installation of Sprinkler Systems.
  - .2 Rooms without Ceilings: Upright sprinklers or as indicated.
  - .3 Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers or as indicated.
  - .4 Wall Mounting: Sidewall sprinklers, or as indicated
  - .5 Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers or as indicated.
  - .6 Deluge-Sprinkler Systems: Upright and pendent, open sprinklers or as indicated.
  - .7 Special Applications: Extended-coverage, flow-control, and quick-response sprinklers or as indicated.
  - .8 High temperature (generator room and similar high temperature areas).
  - .9 Maximum security type sprinkler heads shall be used in Detention Area.
  - .10 Sprinkler heads in the Shared Search Area and other Secured Areas shall be institutional
  - .11 grade, maximum security type, incapable of supporting weight for purpose of detainees'

- .12 self-destruction through hanging. Maximum security type heads shall be complete with
- .13 security closure plate and bolted rigid support collar.
- .14 Detention Rooms: coverage of Detention Rooms shall be provided with one secure, large
- .15 orifice, extended coverage, side wall sprinkler head located on wall of service chase.
- .16 Approval for this configuration shall be obtained from the authorities having jurisdiction,
- .17 including certified testing in accordance with NFPA procedures if necessary, to
- .18 demonstrate acceptable coverage. Sufficient sprinkler heads shall be provided for full coverage if approval for using one side wall head per detention room is not obtainable.
- .19 A listed and approved window sprinkler system shall be provided at glazed areas such as
- .20 corridor doors where necessary to maintain required fire ratings.

3.15 **INSTALLATION OF FIRE BLANKETS**

- .1 Provide fire blankets where shown. Store each blanket in a flush wall mounted cabinet. Confirm exact locations prior to installation.

**END OF SECTION 21 13 13**

1 GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Pipes, fittings, and specialties.
- .2 Specialty valves.
- .3 Sprinkler specialty pipe fittings.
- .4 Sprinklers.
- .5 Alarm devices.
- .6 Manual control stations.
- .7 Control panels.
- .8 Pressure gauges.

1.2 REFERENCE STANDARDS

.1 ASME

- .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
- .2 ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings
- .3 ASME B16.4 Cast Iron Threaded Fittings
- .4 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
- .5 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
- .6 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- .7 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings
- .8 ASME B31.9 Building Services Piping
- .9 ASME B36.10M Welded and Seamless Wrought Steel Pipe

.2 ASTM

- .1 ASTM A47/A47M Standard Specification for Ferritic Malleable Iron Castings
- .2 ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- .3 ASTM A135/A135M Standard Specification for Electric-Resistance-Welded Steel Pipe
- .4 ASTM B75/B75M Standard Specification for Seamless Copper Tube
- .5 ASTM B88 Standard Specification for Seamless Copper Water Tube
- .6 ASTM A733 Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
- .7 ASTM A795/A795M Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
- .8 ASTM A865/A865M Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints
- .9 ASTM B584 Standard Specification for Copper Alloy Sand Castings for General Applications

- .10 ASTM F2014 Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications.
- .3 AWS
  - .1 AWS A5.8M/A5.8 Specification For Filler Metals For Brazing And Braze Welding
- .4 AWWA
  - .1 AWWA C606 Standard for Grooved and Shouldered Joints
  - .2 AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings
- .5 ISO
  - .1 ISO 8201 Alarm systems — Audible emergency evacuation signal — Requirements
- .6 MSS
  - .1 MSS SP-123 Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube
- .7 NEMA
  - .1 NEMA 4
  - .2 NEMA 6P
  - .3 NEMA ICS
- .8 NFPA
  - .1 NFPA 13 Standard for the Installation of Sprinkler Systems
  - .2 NFPA 70 National Electrical Code
  - .3 NFPA 291 NFPA 291 Recommended Practice for Fire Flow Testing and Marking of Hydrants
- .9 ULC listed and/ or FM approved
- .10 National Building Code
- .11 National Fire Code
- .12 AN/ULC-S524 (Standard for the Installation of Fire Alarm Systems)
- .13 CAN/ULC-S537 (Standard for the Verification of Fire Alarm Systems)

### 1.3 DEFINITIONS

- .1 Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure of 1200-kPa (175-psig) maximum.

### 1.4 ACTION SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: For each type of product.
  - .1 Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- .3 Shop Drawings: For dry-pipe sprinkler systems.
  - .1 Include plans, elevations, sections, and attachment details.
  - .2 Include diagrams for power, signal, and control wiring.

- .4 Retain Professional Engineer, licensed in the Province of Ontario, with experience in Work of comparable complexity and scope, to perform the following services as part of the Work of this Section:
  - .1 Design of system and sizing calculations.
  - .2 Review, stamp, and sign shop drawings and design calculations.
  - .3 Monitor and report on manufacturer's quality control tests and reports for compliance with Contract Documents.
- .5 Delegated-Design Submittal: For dry-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer, licensed in the Province of Ontario, responsible for their preparation.
- .6 Regulatory requirements:
  - .1 Prior to purchase and installation of sprinkler system, submit documents to authority having jurisdiction and obtain their approval.
  - .2 Make submissions to authority having jurisdiction well in advance so as not to delay installation.

#### 1.5 INFORMATIONAL SUBMITTALS

- .1 Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - .1 Domestic water piping.
  - .2 Compressed air piping.
  - .3 HVAC hydronic piping.
  - .4 Items penetrating finished ceiling including the following:
  - .5 Lighting fixtures.
  - .6 Air outlets and inlets.
  - .7 All electrical
- .2 Qualification Data: For qualified Installer and Professional Engineer
- .3 Design Data:
  - .1 Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.
- .4 Seismic Qualification Data:
  - .1 Post disaster facility
- .5 Welding certificates.
- .6 Fire-hydrant flow test report.
- .7 Field Test Reports:
  - .1 Fire-hydrant flow test report.
  - .2 Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- .8 Field quality-control reports.



## 1.6 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: For dry-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - .1 Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

## 1.8 QUALITY ASSURANCE

- .1 Installer Qualifications:
  - .1 Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  - .1 Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified Professional Engineer.
  - .2 Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## 2 PRODUCTS

### 2.1 SYSTEM DESCRIPTIONS

- .1 Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.
- .2 Combined Dry-Pipe and Preaction Sprinkler System: Automatic sprinklers are attached to piping containing compressed air or nitrogen. Fire-detection system, located in same area as sprinklers, actuates tripping devices that open dry-pipe valve without loss of air pressure and actuates fire alarm. Water discharges from opened sprinklers.
- .3 Single-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of fire-detection system, located in same area as sprinklers, opens pre-action valve, permitting water to flow into sprinkler piping and to discharge from opened sprinklers.
- .4 Double-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of a fire-detection system, located in same area as sprinklers, will activate the normally closed solenoid but will not open the pre-action valve. Activation of a sprinkler head will not permit water to flow into sprinkler piping. Activation of both the normally closed solenoid valve and automatic sprinkler is required to cause the pre-action valve to open, permitting water to flow into sprinkler piping, and water will then discharge from opened sprinkler.

### 2.2 PERFORMANCE REQUIREMENTS

- .1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .2 Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.

- .3 Standard-Pressure Piping System Component: Listed for 1200-kPa (175-psig) minimum working pressure.
- .4 Delegated Design: Engage a qualified Professional Engineer, as defined in Section 01 40 00 – Quality Requirements, to design dry-pipe sprinkler systems.
- .5 Sprinkler system design shall be approved by authorities having jurisdiction.
  - .1 Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
  - .2 Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
    - .1 Light-Hazard Occupancies: 6.3L/s (100 gpm) for 30 minutes.
    - .2 Ordinary-Hazard Occupancies: 15.75L/s (250 gpm) for 60 to 90 minutes.
    - .3 Extra-Hazard Occupancies: 31.5L/s (500 gpm) for 90 to 120 minutes.
- .6 Seismic Performance: Refer to Section 20 05 50 – Seismic Restraint System.

### 2.3 STEEL PIPE AND FITTINGS

- .1 PVC: Ipex "Brute Brute " Class 200, DR14, rigid, hub and spigot pattern PVC pipe and CSA certified fittings to CSA B137.2 and B137.3, ULC listed and FM approved and complete with gasketed joints.
- .2 Schedule 40 Steel - Grooved Coupling Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with mill or site roll grooved ends, and Victaulic "Fire Lock" or "FIT Style 960 fittings", Gruvlock Fig. #7105 "Sock-It" fittings, Tyco Fire Suppression & Building Products Mechanical Outlet Tee Fig. 730 and Victaulic Style 005, Tyco Fire Suppression & Building Products #772, Gruvlok Rigid-Lite #7400, Shurjoint "Speed" or "Z05" rigid coupling joints or approved equivalent. Snap-Let type or strap type fittings are not acceptable.
- .3 Schedule 40 Steel - Screwed and Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping is to be complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping is to be complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.
- .4 Schedule 10 Steel - Grooved Coupling Joints: Schedule 10 mild black carbon steel, ASTM A53, Grade B, or ASTM A795, Grade A, complete with mill or site roll grooved ends, and Victaulic "Fire Lock" fittings, Tyco Fire Suppression & Building Products grooved fittings and Victaulic Style 005, Tyco Fire Suppression & Building Products #772, Gruvlok Rigid-Lite #7400 rigid coupling joints or approved equivalent. Snap-Let type or strap type fittings are not acceptable.

### 2.4 PIPING JOINING MATERIALS

- .1 Pipe-Flange Gasket Materials: AWWA C110/A21.10, rubber, flat face, 3.2-m (1/8 inch) thick.
  - .1 Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
  - .2 Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- .2 Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.
- .3 Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

### 2.5 SPECIALTY VALVES

- .1 ULc listed and/ or FM approved

- .2 Pressure Rating:
  - .1 Standard-Pressure Piping Specialty Valves: 1200-kPa (175-psig) minimum.
- .3 Body Material: Cast or ductile iron.
- .4 Size: Same as connected piping.
- .5 End Connections: Flanged or grooved.
- .6 Dry-Pipe Valves:
  - .1 ULc listed and/ or FM approved
  - .2 Design: Differential-pressure type.
  - .3 Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
  - .4 Air-Pressure Maintenance Device:
    - .1 ULc listed and/ or FM approved
    - .2 Type: Automatic device to maintain minimum air pressure in piping.
    - .3 Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 95- to 410-kPa (14- to 60-psig) adjustable range, and 1200-kPa (175-psig) outlet pressure.
  - .5 Air Compressor:
    - .1 ULc listed and/ or FM approved
    - .2 Motor Horsepower: Fractional.
    - .3 Power: 120-V ac, 60 Hz, single phase.
    - .4 Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
    - .5 Include filters, relief valves, coolers, automatic drains, and gauges.
- .7 Pre-Action Valves:
  - .1 ULc listed and/ or FM approved.
  - .2 Design: Hydraulically operated, differential-pressure type.
  - .3 Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
  - .4 Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gauges; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
  - .5 Air-Pressure Maintenance Device:
    - .1 ULc listed and/ or FM approved
    - .2 Type: Automatic device to maintain minimum air pressure in piping.

- .3 Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 95- to 410-kPa (14- to 60-psig) adjustable range, and 1200-kPa (175-psig) outlet pressure.
- .6 Air Compressor:
  - .1 Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  - .2 Motor Horsepower: Fractional.
  - .3 Power: 120-V ac, 60 Hz, single phase.
  - .4 Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
  - .5 Include filters, relief valves, coolers, automatic drains, and gauges.
- .8 Automatic (Ball Drip) Drain Valves:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1200-kPa (175-psig) minimum.
  - .3 Type: Automatic draining, ball check.
  - .4 Size: DN 20 (NPS ¾).
  - .5 End Connections: Threaded.

## 2.6 SPRINKLER PIPING SPECIALTIES

- .1 General Requirements for Dry-Pipe System Fittings: ULc listed and/ or FM approved for dry-pipe service.
- .2 Branch Outlet Fittings:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1200-kPa (175-psig) minimum.
  - .3 Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  - .4 Type: Mechanical-tee and -cross fittings.
  - .5 Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
  - .6 Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
  - .7 Branch Outlets: Grooved, plain-end pipe, or threaded.
- .3 Flow Detection and Test Assemblies:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1200-kPa (175-psig).
  - .3 Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
  - .4 Size: Same as connected piping.
  - .5 Inlet and Outlet: Threaded.
- .4 Branch Line Testers:
  - .1 ULc listed and/ or FM approved

- .2 Pressure Rating: 1200-kPa (175-psig) minimum.
- .3 Body Material: Brass.
- .4 Size: Same as connected piping.
- .5 Inlet: Threaded.
- .6 Drain Outlet: Threaded and capped.
- .7 Branch Outlet: Threaded, for sprinkler.
- .5 Sprinkler Inspector's Test Fittings:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1200-kPa (175-psig) minimum.
  - .3 Body Material: Cast- or ductile-iron housing with sight glass.
  - .4 Size: Same as connected piping.
  - .5 Inlet and Outlet: Threaded.
- .6 Adjustable Drop Nipples:
  - .1 ULc listed and/ or FM approved
  - .2 Pressure Rating: 1725-kPa (250-psig) minimum.
  - .3 Body Material: Steel pipe with EPDM O-ring seals.
  - .4 Size: Same as connected piping.
  - .5 Length: Adjustable.
  - .6 Inlet and Outlet: Threaded.
- .7 Flexible Sprinkler Hose Fittings:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
  - .3 Pressure Rating: 1200-kPa (175-psig) minimum.
  - .4 Size: Same as connected piping, for sprinkler.

## 2.7 SPRINKLERS

- .1 ULc listed and/ or FM approved
- .2 Pressure Rating for Residential Sprinklers: 1200-kPa (175-psig) maximum.
- .3 Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.
- .4 Pressure Rating for High-Pressure Automatic Sprinklers: 1725-kPa (250-psig) minimum.
- .5 Automatic Sprinklers with Heat-Responsive Element:
  - .1 ULc listed and/ or FM approved
  - .2 Characteristics: Nominal 12.7-mm (1/2-inch) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- .6 Sprinkler Finishes:
  - .1 Pendent: Chrome plated.
  - .2 Upright: Brass body.

- .7 Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  - .1 Ceiling Mounting: Chrome-plated steel, two piece, with 25-mm (1-inch) vertical adjustment.
  - .2 Sidewall Mounting: Chrome-plated steel, one piece, flat.
- .8 Sprinkler Guards:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Wire cage with fastening device for attaching to sprinkler.

## 2.8 ALARM DEVICES

- .1 Alarm-device types shall match piping and equipment connections.
- .2 Water-Motor-Operated Alarm:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Mechanically operated, with Pelton wheel.
  - .3 Alarm Gong: Cast aluminum with red-enamel factory finish.
  - .4 Size: 1250-mm (10-inch) diameter.
  - .5 Components: Shaft length, bearings, and sleeve to suit wall construction.
  - .6 Inlet: DN 20 (NPS ¾).
  - .7 Outlet: DN 25 (NPS 1) drain connection.
- .3 Electrically Operated Alarm Notification Appliances:
  - .1 Electric Bell:
    - .1 ULc listed and/ or FM approved
    - .2 Type: Vibrating, metal alarm bell.
    - .3 Size: 150-mm (6-inch) minimum diameter.
    - .4 Voltage: 120 V ac, 60 Hz, 1 phase.
    - .5 Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
  - .2 Strobe/Horn:
    - .1 Standard: UL 464 listed.
    - .2 Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
    - .3 Voltage: 120 V ac, 60 Hz.
    - .4 Effective Intensity: 110 cd.
    - .5 Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
    - .6 Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police, or fire department.

- .4 Pressure Switches - Water-Flow Alarm Detection:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Electrically supervised, pressure-activated water-flow switch.
  - .3 Components: Two single-pole, double-throw switches.
  - .4 Design Operation: Rising pressure to 40-kPa (6 psi) plus or minus signals water flow.
  - .5 Adjustability: Each switch is to be independently adjustable.
  - .6 Wire Separation: Pressure switch to provide separation of wiring to each switch connection to allow for low and high-volume connections to comply with NFPA 70 Article 760 requirements.
- .5 Pressure Switches - Low/High Air Pressure Supervisory:
  - .1 ULc listed and/ or FM approved
  - .2 Type: Electrically supervised pressure supervisory switch.
  - .3 Components: Two single-pole, double-throw switches.
  - .4 Design Operation: Detects increase and/or decrease from normal supervisory air pressure.
  - .5 Adjustability: Each switch is to be independently adjustable.
  - .6 Wire Separation: Pressure switch shall provide for separation of wiring to each switch connection to allow for low and high voltage connections to comply with NFPA 70 Article 760 requirements.
- .6 Valve Supervisory Switches:
  - .1 General Requirements for Valve Supervisory Switches:
    - .1 ULc listed and/ or FM approved
    - .2 Type: Electrically supervised.
    - .3 Design: Signals that controlled valve is in other than fully open position.
    - .4 Wire Terminal Designations: Indicates normal switch position when switch is properly installed on the valve and valve is fully open.
  - .2 Requirements for OS&Y Valve Supervisory Switches:
    - .1 Components: One or two single-pole, double-throw switches.
    - .2 NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
    - .3 Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
    - .4 Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
    - .5 Trip Rod Length: Adjustable.
  - .3 Requirements for PIV and Butterfly Valve Supervisory Switches:
    - .1 Components: Two single-pole, double-throw switches.
    - .2 NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
    - .3 Mounting Hardware: Removable nipple.

- .4 Trip Rod Length: Adjustable.
- .4 Requirements for Ball Valve Supervisory Switch:
  - .1 Components: One single-pole, double-throw switch.
  - .2 NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
  - .3 Mounting Hardware: Suitable for mounting directly to pipe, ball valves or backflow preventers sized from up to DN 50 (NPS 2).

## 2.9 MANUAL CONTROL STATIONS

- .1 ULc listed and/ or FM approved for hydraulic operation, with union, DN 15 (NPS ½) pipe nipple, and bronze ball valve.
- .2 Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.10 DETECTION SYSTEM

- .1 Provide CSA / ULc listed and/ or FM approved complete smoke and heat detection system.
- .2 Automatic & manual detection devices: Supply and install a complete electrical detection system including conduit as per Division 26 requirements, wiring, heat and/or smoke detectors, manual pull stations, and connections to auxiliary functions, alarm horns and strobes at each entrance to the area served, suited for operation in designated room/ area operation and functionality.
- .3 Submit shop drawings depicting all technical information, wiring diagrams, interfaces, interlocks and layout of all devices.
- .4 Notification devices and signs: Supply and install a complete notification system including conduit, wiring, and notification devices.
- .5 The devices must be compatible with the release control panel.

## 2.11 CONTROL PANELS

- .1 Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
  - .1 ULc listed and/ or FM approved when used with thermal detectors and Class A detector circuit wiring.
  - .2 Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
  - .3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application
- .2 Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- .3 Manual Control Stations: Hydraulic operation, with union, DN 15 (NPS ½) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- .4 Panels Components:
  - .1 Power supply.
  - .2 Battery charger.



- .3 Standby batteries.
- .4 Field-wiring terminal strip.
- .5 Electrically supervised solenoid valves and polarized fire-alarm bell.
- .6 Lamp test facility.
- .7 Single-pole, double-throw auxiliary alarm contacts.
- .8 Rectifier.

## 2.12 PRESSURE GAUGES

- .1 ULc listed and/ or FM approved
- .2 Dial Size: 90-to-115-mm (3-1/2- to 4-1/2-inch) diameter.
- .3 Pressure Gauge Range: 0-to-1725-kPa (0- to 250-psig) minimum.
- .4 Label: Include "WATER" or "AIR/WATER" label on dial face.
- .5 Air System Piping Gauge: Include "AIR" or "AIR/WATER" label on dial face.

## 3 EXECUTION

### 3.1 PREPARATION

- .1 Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- .2 Report test results promptly and in writing.

### 3.2 SERVICE-ENTRANCE PIPING

- .1 All underground fire suppression piping outside the building footprint (from the outside of the foundation wall to the property line) shall be covered by the civil discipline.
- .2 Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 21 13 13 – Wet Pipe Sprinkler Systems.

### 3.3 PIPING INSTALLATION

- .1 Pipe, unless otherwise specified, is to be as follows:
  - .1 For underground pipe inside the building - Ipex "Blue Brute" Class 200, DR14 rigid PVC, braced and secured at bends and tees with concrete blocks in accordance with Municipal standards and details, and complete with No. 14 gge solid copper plastic insulated wire secured to the top of the pipe for the entire length of the pipe fastened with plastic type ties for pipe location tracing purposes. Lay pipes true to line and grade with bells up grade. Fit sections together so that, when complete, the pipe has a smooth and uniform invert. Keep pipe thoroughly clean so that jointed compound will adhere. Inspect the pipe for defects before being lowered into the trench. Do not use defective pipe. All non ferrous piping shall be changed to ferrous piping prior to entering the building using an EBAA iron Inc. Mega-Coupling Series 3800 or equivalent. (i.e., changed before passing through basement floor or slab on grade).
  - .2 For all underground ductile iron pipe provide Polyethylene Film: ANSI/AWWA C105/A21.5 with minimum nominal thickness of 200 microns and minus tolerance with 10 percent. Provide tubes for straight pipe and sheets for fittings or tees. Securing tape: Thermoplastic material with minimum thickness 200 microns, width 25mm, and pressure sensitive adhesive face capable of bonding to metal, bituminous coating and polyethylene

- .3 For piping inside building and above ground from service connection to discharge side of alarm valve, etc. - Schedule 40 grooved end black steel with Victaulic fittings and coupling joints, or, for piping to and including 50 mm (2 inch) diameter, screwed fittings and joints or piping 65 mm (2-1/2 inch) diameter and larger, welding fittings and welded joints.
- .4 For pipe inside building and above ground to exterior pump test hose valve header and for fire department connection - Schedule 40 black steel as above.
- .5 For piping downstream of "head end" alarm valve(s) and equipment – Schedule 10 black steel pipe with Victaulic fittings and coupling joints or Schedule 40 black steel pipe with screwed fittings and joints.
- .6 Galvanized for Dry Piping and Pre-Action System Piping.
- .2 Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
  - .1 Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Consultant before deviating from approved working plans.
  - .2 Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- .3 Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- .4 Install seismic restraints on piping. Comply with NFPA 13 requirements and Section 20 05 50 – Seismic Restraint System for seismic-restraint device materials and installation.
- .5 Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- .6 Install unions adjacent to each valve in pipes DN 50 (NPS 2) and smaller.
- .7 Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.
- .8 Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- .9 Install sprinkler piping with drains for complete system drainage.
- .10 Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- .11 Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.
- .12 Connect compressed-air supply to dry-pipe sprinkler piping.
- .13 Connect air compressor to the following piping and wiring:
  - .1 Pressure gauges and controls.
  - .2 Electrical power system.
  - .3 Fire-alarm devices, including low-pressure alarm.
- .14 Install alarm devices in piping systems.
- .15 Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13. In seismic-rated areas, refer to Section 20 05 50 – Seismic Restraint System.
- .16 Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than DN 8 (NPS 1/4) and

with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gauges to permit removal and install where they are not subject to freezing.

- .17 Drain dry-pipe sprinkler piping.
- .18 Pressurize and check dry-pipe sprinkler system piping and air compressors.
- .19 Install sleeves for piping penetrations of walls, ceilings, and floors.
- .20 Install sleeve seals for piping penetrations of concrete walls and slabs.
- .21 Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.4 JOINT CONSTRUCTION

- .1 Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- .2 Install unions adjacent to each valve in pipes DN 50 (NPS 2) and smaller.
- .3 Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.
- .4 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- .5 Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- .6 Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- .7 Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - .1 Apply appropriate tape or thread compound to external pipe threads.
  - .2 Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- .8 Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- .9 Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- .10 Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe
- .11 Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- .12 Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- .13 Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.5 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- .1 Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

### 3.6 VALVE AND SPECIALTIES INSTALLATION

- .1 Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- .2 Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- .3 Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- .4 Specialty Valves:
  - .1 Install valves in vertical position for proper direction of flow, in main supply to system.
  - .2 Install dry-pipe valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
    - .1 Install air compressor and compressed-air-supply piping.
    - .2 Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 95-to-410-kPa (14- to 60-psig) adjustable range; and 1200-kPa (175-psig) maximum inlet pressure.
    - .3 Install compressed-air-supply piping from building's compressed-air piping system.

### 3.7 SPRINKLER INSTALLATION

- .1 Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- .2 Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- .3 Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

### 3.8 IDENTIFICATION

- .1 Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- .2 Identify system components, wiring, cabling, and terminals. Follow the same identification requirements as those specified for the Fire Alarm System.

### 3.9 FIELD QUALITY CONTROL

- .1 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - .1 Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
  - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - .3 Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - .4 Energize circuits to electrical equipment and devices.
  - .5 Start and run air compressors.
  - .6 Coordinate with fire-alarm tests. Operate as required.

- .7 Coordinate with fire-pump tests. Operate as required.
- .8 Verify that equipment hose threads are same as local fire department equipment.
- .2 Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- .3 Prepare test and inspection reports.

3.10 **CLEANING**

- .1 Clean dirt and debris from sprinklers.
- .2 Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 **DEMONSTRATION**

- .1 Engage a factory-authorized service representative to train Project Co. and Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 **SPRINKLER SCHEDULE**

- .1 Use sprinkler types in subparagraphs below for the following applications:
  - .1 Rooms without Ceilings: Upright sprinklers or as indicated
  - .2 Rooms with Suspended Ceilings: Dry pendent sprinklers, Dry recessed sprinklers or as indicated.
  - .3 Wall Mounting: Dry sidewall sprinklers or as indicated
  - .4 Spaces Subject to Freezing: Upright sprinklers.
  - .5 Special Applications: Extended-coverage and quick-response sprinklers or as indicated.
  - .6 High temperature (generator room and similar high temperature areas)

**END OF SECTION 21 13 16**

1 GENERAL

1.1 SUMMARY

.1 Section Includes:

- .1 Dual Clean-agent and pre-action fire-extinguishing systems.
- .2 Pipe and fittings.
- .3 Valves.
- .4 Extinguishing-agent containers.
- .5 Fire-extinguishing clean agent.
- .6 Discharge nozzles.
- .7 Manifold and orifice unions.
- .8 Fire control panels.
- .9 Detection devices.
- .10 Manual stations.
- .11 Switches.
- .12 Alarm devices.

1.2 REFERENCE STANDARDS

.1 ASME

- .1 ASME Boiler and Pressure Vessel Code
- .2 ASME B16.2 Metallic Gaskets for Pipe Flanges
- .3 ASME B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

.2 ASTM

- .1 ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- .2 ASTM A536 Standard Specification for Ductile Iron Castings
- .3 ASTM A106/A106M Pipe Specifications

.3 AWWA

- .1 AWWA C606 Grooved and Shouldered Joints

.4 AWS

- .1 AWS D10.12M/D10.12 Guide for Welding Mild Steel Pipe

.5 NFPA

- .1 NFPA 13 Standard for the Installation of Sprinkler Systems
- .2 NFPA 70 National Electrical Code
- .3 NFPA 72 National Fire Alarm and Signaling Code
- .4 NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems

.6 ULC listed and/ or FM approved

- .1 UL

- .2 UL 213 Standard for Rubber Gasketed Fittings for Fire-Protection Service
- .3 UL 268 Smoke Detectors for Fire Alarm Systems
- .7 Ontario Building Code
- .8 Ontario Fire Code
- .9 AN/ULC-S524 (Standard for the Installation of Fire Alarm Systems)
- .10 CAN/ULC-S537 (Standard for the Verification of Fire Alarm Systems)

### 1.3 DEFINITIONS

- .1 EPO: Emergency Power Off.

### 1.4 ACTION SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: For each type of product indicated.
- .3 Shop Drawings: Prepare in accordance with requirements of NFPA 13 and NFPA 2001, to include, but not be limited to, the following:
  - .1 Include plans, elevations, sections, and attachment details.
  - .2 Include design calculations.
  - .3 Include details of equipment assemblies. Indicate dimensions, weights, loads, manufacturer-required clearances, method of field assembly, components, and location and size of each field connection.
  - .4 Include diagrams for power, signal, and control wiring.
  - .5 Permit-Approved Documents: Working plans and hydraulic calculations approved by authorities having jurisdiction.
  - .6 Mounting and installation details of addressable modules, integrated pull station/abort switch, strobes, electronic horns, valves, piping, cylinders, etc.
  - .7 Battery capacity calculations
  - .8 Control equipment and agent releasing panel, physical arrangement and features, rack arrangement and interconnection wiring
  - .9 Installation manual
  - .10 Programming manual
  - .11 Complete parts list for system components
  - .12 Complete input/output listing and assignments of devices
  - .13 Complete manufacturer's technical data for devices and control panel components
  - .14 Applications manual
  - .15 product data sheets to indicate:
    - .1 performance criteria, compliance with appropriate reference standards, characteristics, limitations, and trouble-shooting protocol
    - .2 a complete description of the system operation
    - .3 product storage, handling and installation requirements
- .4 System Design Calculations: Submit complete design and computerized verification of flow calculations with, as a minimum, the following data:
  - .1 quantity of agent per nozzle

- .2 type of nozzle
- .3 pressure at nozzle
- .4 nozzle body nominal pipe size
- .5 number and size of cylinders
- .6 total agent
- .7 pipe size per pipe section
- .8 pipe schedule per pipe section
- .9 number, size and type of fitting per pipe section
- .10 actual length per pipe section
- .11 equivalent length per pipe section
- .12 discharge time
- .13 calculated room volume with details of discounted elements
- .14 design concentration
- .15 design concentration safety factor
- .16 Inspection Report: Submit an inspection and test report and certification by supplier confirming that the installation is in accordance with the Contract Documents and manufacturer's requirements.
- .5 Retain Professional Engineer, licensed in the Province of Ontario, with experience in Work of comparable complexity and scope, to perform the following services as part of the Work of this Section:
  - .1 Design of clean agent fire suppression and pre-action system and sizing calculations.
  - .2 Review, stamp, and sign shop drawings and design calculations.
  - .3 Monitor and report on manufacturer's quality control tests and reports for compliance with Contract Documents.
  - .4 Certify system in accordance with requirements of NFPA 13 and NFPA 2001.
- .6 Delegated-Design Submittal: For clean-agent fire-extinguishing and pre-action systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.
- .7 Regulatory requirements:
  - .1 Prior to purchase and installation of sprinkler system, submit documents to authority having jurisdiction and obtain their approval.
  - .2 Make submissions to authority having jurisdiction well in advance so as not to delay installation.

#### 1.5 INFORMATIONAL SUBMITTALS

- .1 Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Coordinate for enclosure integrity in accordance with NFPA 13 and NFPA 2001 requirements.
- .2 Qualification Data: For qualified Installer and Professional Engineer
- .3 Seismic Qualification Data:
  - .1 Post disaster facility
  - .2 Certificates for extinguishing-agent containers and control panels, from manufacturer.



- .1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- .2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- .3 Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- .4 Welding certificates.
- .5 Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: For clean-agent fire-extinguishing and pre-action system to include in emergency, operation, and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - .1 Detection Devices: Not less than 20 percent of amount of each type installed.
  - .2 Container Valves: Not less than 10 percent of amount of each size and type installed.
  - .3 Nozzles: Not less than 20 percent of amount of each type installed.
  - .4 Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

#### 1.8 QUALITY ASSURANCE

- .1 Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

### 2 PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- .1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70CSA/ ULC, by an NRTL, and marked for intended location and application.
- .2 ULc Compliance: Provide equipment listed in ULc's "Fire Protection Equipment Directory."
- .3 Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7.
  - .1 The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - .2 Component Importance Factor: 1.5. Design criteria: Post disaster facility.

#### 2.2 SYSTEM DESCRIPTION

- .1 Supply and install a fire suppression system combining Pre-action system with clean agent system, Engineered Novec™ 1230 type as indicated, including:
  - .1 Clean agent suppression system
  - .2 Pre-action Double Interlock
  - .3 Dual agent Releasing Control Panel
  - .4 The integrated unit shall include an FM Approved SEVO (or approved alternative) clean agent system.

- .2 Extinguishing agent shall be Novec 1230, Dodecafluoro-2-methylpentan-3-one. Novec 1230 is a trade name for FK-5-1-12 fire extinguishing clean agent, manufactured by 3M

## **2.3 CLEAN-AGENT SYSTEMS**

- .1 Source Limitations: Obtain clean-agent systems from single source from single manufacturer.
- .2 The NOVEC™ 1230 system shall be a 500psi Engineered type system. It shall have a minimum design of 4.2% volumetric concentration for Class A hazard and a minimum of 5.85% volumetric concentration for Class B hazard, minimum concentration for Class C hazard shall be at least that for Class A surface fire, at the minimum anticipated temperature with the protected area.
- .3 System design shall not exceed 10% for normally occupied spaces, adjusted for maximum space temperature anticipated altitude and with provisions for room evacuation before agent release.
- .4 System shall provide total flooding Novec 1230 concentration in maximum 10 seconds for a 10 minutes holding time.

## **2.4 PRE-ACTION SYSTEMS**

- .1 Source Limitations: Obtain clean-agent systems from single source from single manufacturer
- .2 System design as per drawings occupancy hazard depicted requirements.

## **2.5 CLEAN AGENT**

- .1 Supply and install an integrated Novec™ 1230 clean agent suppression system containing all hydraulic, pneumatic, fire extinguishing fluid and devices, and electrical components required for the control of an integrated clean agent system.
- .2 Integrated clean agent system
  - .1 SEVO (or approved alternative) 1230 clean agent storage cylinder(s) assembly steel pressure vessel c/w pressure supervisory switch, manufactured, tested and stamped in accordance with applicable DOT and Transport Canada markings. The agent storage cylinder(s) will be pressurized with 500 psi of nitrogen at the factory. Cylinders of 322 & 601 lbs capacity should also be provided with a liquid level indicator.
  - .2 3M™ Novec™ 1230 fire protection fluid (also known as FK-5-1-12). Agent shall not contain any hydro-fluorocarbons (HFCs).
  - .3 SEVO (or approved alternative) Discharge Valve Assembly shall be of brass construction and designed as per the pressure differential concept. It shall be complete with piston, seal, siphon tube, pressure gauge and releasing controls including electric actuator.
  - .4 A Pressure Supervisory Switch shall be provided on the SEVO (or approved alternative) cylinder to monitor the pressure within the cylinder should a loss of nitrogen occur. The low pressure switch is wired to a supervisory circuit to provide a Supervisory indication upon activation.
- .3 Integrated Pre-action System
  - .1 Viking Deluge Valve model F-1 (or approved alternative), complete with releasing trim rated at 250 psi and all the necessary accessories. Trim shall include a mechanical latching device to prevent system from resetting in case of loss of power to the release solenoid. Systems provided with solenoid only, without this mechanical latching device, shall not be accepted. Every valve shall be clearly identified as to its operation with arrows indicating all positions to facilitate system operation.

- .2 Pressure gauges to indicate water supply, priming water and air pressures of the system. Each pressure gauge must be provided with its own three-way valve and shall be clearly identified.
- .3 Release trim with solenoid valve and every supervisory and alarm device required shall be Schedule 40 galvanized steel. Black pipe will not be accepted.
- .4 Schedule 40 steel pipe header shall be painted fire red, with grooved ends to be connected to supply water.
- .5 Schedule 40 steel pipe drain manifold of 2" diameter shall be painted fire red, with grooved ends for drain connections.
- .6 Trim shall include properly identified contractor test ports factory mounted into the trim piping to facilitate system testing and commissioning.
- .4 Integrated release control panel
  - .1 Potter PFC-4410RC (or approved alternative) dual agent integrated control panel with emergency batteries
  - .2 Field wiring terminal strips integrated with the panel for connection of field wiring.
- .5 The system shall be complete in all ways.
- .6 The system shall incorporate all components required for complete system operation

## 2.6 INTEGRATED CONTROL PANEL

- .1 The release control panel must be fully integrated with the clean agent system and installed in its own enclosure.
  - .1 The control panel shall be FM Approved for clean agent release and in conformance to UL 864-9. Panel shall include four programmable Class B, Style B initiating zones, two class B supervisory zones, and four programmable output circuits. Onboard, menu-driven programming with pre-installed programs for ease of set-up must also be provided. The panel must be compatible with many different initiating devices including linear heat detection, smoke and heat detectors, water flow indicators, low air pressure switches, and manual pull stations.
  - .2 The control panel should include both an LCD Annunciator describing all system conditions (16 characters on 2 lines) and a set of red & yellow LED lamps identifying each separate alarm and trouble conditions. Easy to operate control buttons shall also be included for the operation of the panel various functions.
  - .3 The control panel should be pre-wired at the factory to a set of industrial grade wiring terminals used for power feed. External wiring to field devices should also be wired by the installing contractor to the set of wiring terminals provided.
  - .4 A set of emergency batteries should be provided with the control panel. Batteries should be calculated to provide emergency power for 90 hours after which they shall be able to provide 10 minutes of alarm and activation of the solenoid valve(s).

## 2.7 AUTOMATIC AND MANUAL DETECTION DEVICES

- .1 Supply and install a complete electrical detection system including conduit, wiring, heat and/or smoke detectors, manual pull stations, abort stations and connections to auxiliary functions.
- .2 Heat and/or smoke detectors should be wired on either Zones 1 or 2. Where more than the allowable quantity of detectors is required on a same detection zone, use the recommended 4-wire type detector base for that detector
- .3 Manual pull stations shall be connected on Zone 4

- .4 Provide Abort stations. Abort stations shall be “dead man” type and connected on Supervisory Zone 1

## 2.8 NOTIFICATION DEVICES AND SIGNS

- .1 Supply and install a complete notification system including Conduit, wiring, and notification devices.
- .2 The NAC devices (24 Vdc bell, horn or strobe) must be compatible with the release control panel.
- .3 Audible & visual pre-discharge alarms shall be provided within the protected area to give positive warning of impending discharge.

## 2.9 CAUTION & ADVISORY SIGNS

- .1 Warning and instruction signs at entrance to and inside protected areas shall be provided.
- .2 A manual discharge sign is required at each manual release station and clearly indicate which hazard is controlled by the station.

## 2.10 SEQUENCES OF OPERATION

- .1 System sequence of operation shall be pre-set at the factory and perform the following:
  - .1 Actuation of one (1) detector within the system:
    - .1 “COMMON ALARM” light flashes.
    - .2 “ZONE 1 or 2” light flashes.
    - .3 “DETECTION ZONE #1 or #2” message appears on the LCD.
    - .4 “1st alarm output” activates
    - .5 “ALARM” contact activates.
  - .2 Actuation of a 2nd detector within the system:
    - .1 “Pre-Discharge” light flashes.
    - .2 “ZONE 1 or 2” light flashes.
    - .3 “DETECTION ZONE #1 or #2” message appears on the LCD.
    - .4 “2nd alarm output” activates
    - .5 Pre-discharge delays starts. (Not to exceed 60 sec.)
  - .3 After completion of the Pre-discharge delay sequence:
    - .1 “Discharge” light illuminate steady.
    - .2 NOVEC 1230 electric actuator activates
    - .3 “ZONE 3” light flashes. (if discharge option selected)
    - .4 “WATERFLOW ZONE #3” message appears on the LCD. (if discharge option selected)
    - .5 “WATERFLOW” contact activates. (if discharge option selected)
    - .6 “OUTPUT #4 RELEASING” message appears on the LCD.
    - .7 Pre-action electric solenoid valve activates.
    - .8 “OUTPUT #3 RELEASING” message appears on the LCD.
    - .9 Pre-action will not be filled with water at this time.
  - .4 After a Pre-action sprinkler head fuses:

- .1 Pre-action Valve opens, water will flow into the sprinkler piping and out of sprinklers and any opening on the system.
- .2 "ZONE 3" light flashes. (if not activated at step C)
- .3 "WATERFLOW ZONE #3" message appears on the LCD. (if not activated at step C)
- .4 "WATERFLOW" contact activates. (if not activated at step C)
- .2 Provide interface and interlock with the fire alarm and BAS systems.

#### 2.11 CLEAN AGENT SYSTEM PIPING

- .1 Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.
- .2 Steel Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106/A106M, Grade A and Grade B; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.
  - .1 Threaded Fittings:
    - .1 Malleable-Iron Fittings: ASME B16.3, Class 300.
    - .2 Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
    - .3 Fittings Working Pressure: 4278 kPa (620-psig) minimum.
    - .4 Flanged Joints: Class 300 minimum.
  - .2 Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
  - .3 Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A47/A47M malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved in accordance with AWWA C606.
- .3 Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - .1 ASME B16.21, nonmetallic, flat, asbestos-free, 3.2-mm (1/8-inch) maximum thickness unless thickness or specific material is indicated.
- .4 Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- .5 Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- .6 Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

#### 2.12 PRE-ACTION SYSTEM PIPING

- .1 System piping and fittings shall comply with NFPA 13 requirements.

#### 2.13 PRE-ACTION AUTOMATIC SPRINKLERS

- .1 Supply and install all required automatic sprinklers
- .2 Sprinklers shall be glass bulb type, UL/ULC listed and FM approved and shall comply with NFPA 13 requirements.

#### 2.14 VALVES

- .1 General Valve Requirements:
  - .1 UL listed or FM Approved for use in fire-protection systems.

- .2 Compatible with type of clean agent used.
- .2 Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.
- .3 Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
- .4 Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

#### 2.15 EXTINGUISHING-AGENT CONTAINERS

- .1 Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
  - .1 Finish: Red, enamel or epoxy paint.
  - .2 Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
  - .3 Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
  - .4 Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

#### 2.16 DISCHARGE NOZZLES

- .1 Nozzles shall be SEVO (or approved alternative) 1230 Engineered Nozzles. 360° (central) and 180° (sidewall) nozzles shall be installed as per the manufacturer's recommendation in the design manual.

#### 2.17 AIR SUPPLY

- .1 The automatic sprinkler piping is supervised by compressed air from a source supplied by the installer.
- .2 The air compressor must be of the proper size in order to be able to restore normal system air pressure within 30 minutes.2.12 Sprinkler System Drain
- .3 A single drain collector shall be connected to an open drain (open end pipe with an air gap around the drain pipe or equivalent).
- .4 The drain piping shall not be restricted or reduced and shall be of the same diameter as the drain collector. It shall also be arranged to avoid back-pressurizing the drain trim.
- .5 Multiple drain collectors and open drain cups will not be accepted.
- .6 Open drain should be outside the protected area, if installed inside protected area, drain should have traps to avoid gas leakage on discharge.
- .7 Manifolding of multiple units is permitted provided the manufacturer's recommendations are carefully followed and complied with.

#### 2.18 DETECTION DEVICES

- .1 Description: Comply with NFPA 2001, NFPA 72, and UL 268; 24 V dc, nominal.
- .2 Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
- .3 Photoelectric Detectors: LED light source and silicon photodiode receiving element.

- .4 Remote Air-Sampling Detector System: Includes air-sampling pipe network, laser-based photoelectric detector, sample transport fan, and control unit.
  - .1 Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
  - .2 Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
  - .3 Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 12.5 Pa (0.05 inch wg) at all sampling ports.
  - .4 Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
- .5 Signals to the Central Fire-Alarm Control Panel: Any type of local system trouble is reported to central fire-alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to central fire-alarm control panel as separately identified zones.

## 2.19 MANUAL STATIONS

- .1 Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.
- .2 Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
- .3 Abort Switch: "ABORT" caption, momentary contact, with green finish.

## 2.20 SWITCHES

- .1 Description: FM Approved or NRTL listed, where available, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.
  - .1 Low-Agent Pressure Switches: Pneumatic operation.
  - .2 Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
  - .3 Door Closers: Magnetic retaining and release device or electrical interlock to cause door operator to drive the door closed.

## 2.21 ALARM DEVICES

- .1 Description: FM Approved or NRTL listed, low voltage, and surface mounting. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" or Section 284621.13 "Conventional Fire-Alarm Systems" for alarm and monitoring devices.
- .2 Bells: CSA approved, Minimum 150-mm (6-inch) diameter.
- .3 Horns: CSA approved, 90 to 94 dBA.
- .4 Strobe Lights: CSA approved, Translucent lens, with "FIRE" or similar caption.
- .5 Oxygen Deficiency Monitor.
  - .1 Sampling Method and Range: Diffusion, zero to 25 percent O<sub>2</sub>.
  - .2 24 V dc.
  - .3 Wall mounted with bracket.
  - .4 Built-in audible alarm 90 dBA.
  - .5 Backlit LCD.
  - .6 10-year no-calibration sensor.

- .7 No maintenance required.
- .8 Signal Outputs: Standard 4- to 20-mA analog.
- .9 Connections for system control data acquisition system and/or programmable logic controller.
- .10 Plus or minus 1 percent accuracy of full scale.
- .11 Operating temperature of minus 40 to plus 50 deg C (minus 40 to plus 122 deg F).

## 2.22 INTERLOCKS AND INTERFACE

- .1 Supply and install interlock replays, wiring & conduit for shutdown of HVAC equipment, air dampers, etc., electrical power supplies, or shunt trip breaker.
- .2 Provide fire alarm interface. Refer to fire alarm for further requirements.
- .3 Provide BAS interface. Refer to control drawings and BAS specifications for further requirements.

## 3 EXECUTION

### 3.1 EXAMINATION

- .1 Examine areas and conditions, with Installer present, for compliance with enclosure integrity requirements, installation tolerances, and other conditions affecting performance of the Work in accordance with NFPA 2001.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.
- .3 The installation must meet National & Local standards and be done according to all applicable laws, regulations and codes.
- .4 The proper operation and coordination for the system's installation, including the clean agent system, detection system, signaling system and initial start-up are all under the responsibility of the fire protection contractor.

### 3.2 CLEAN-AGENT SYSTEM INSTALLATION

- .1 Install clean-agent containers, piping, and other components level and plumb, in accordance with manufacturers' written instructions.
- .2 Clean-Agent Container Mounting:
  - .1 Install clean-agent containers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- .3 Comply with requirements for vibration isolation and seismic-control devices specified in Section 200550 – Seismic Restraint System.
- .4 Comply with requirements for vibration isolation devices specified in Section 20 05 48 – Vibration Isolation.
- .5 Install pipe and fittings, valves, and discharge nozzles in accordance with requirements listed in NFPA 2001, Section "Distribution."
  - .1 Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
  - .2 Support piping using supports and methods in accordance with NFPA 13.
  - .3 Install seismic restraints for extinguishing-agent piping systems.



- .4 Install control panels, detection system components, alarms, and accessories, in accordance with requirements listed in NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

### 3.3 PIPING CONNECTIONS

- .1 Drawings indicate general arrangement of piping, fittings, and specialties.
- .2 Where installing piping adjacent to equipment, allow space for service and maintenance.

### 3.4 ELECTRICAL CONNECTIONS

- .1 Connect wiring in accordance with Division 26.
- .2 Ground equipment in accordance with Division 26.
- .3 Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with CSA and Electrical Code.
- .4 Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
- .5 Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 28 46 21.11 – Addressable Fire-Alarm Systems or Section 28 46 21.13 – Conventional Fire-Alarm Systems.

### 3.5 CONTROL CONNECTIONS

- .1 Install control and electrical power wiring to field-mounted control devices.
- .2 Connect control wiring in accordance with Section 26 05 23 – Control-Voltage Electrical Power Cables.

### 3.6 IDENTIFICATION

- .1 Identify system components and equipment.
- .2 Identify piping, extinguishing-agent containers, other equipment, and panels in accordance with NFPA 13 and 2001.
- .3 Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- .4 Install signs at entry doors to advise persons outside the room the meaning of horn(s), bell(s), and strobe light(s) outside the protected space.

### 3.7 FIELD QUALITY CONTROL

- .1 Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- .2 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- .3 Perform tests and inspections with the assistance of a factory-authorized service representative.
- .4 Tests and Inspections:
  - .1 After installing clean-agent fire-extinguishing system and after electrical circuitry has been energized, test for compliance in accordance with requirements listed in NFPA 2001, Section "Approval of Installation."
  - .2 Clean-agent fire-extinguishing system and associated protected enclosure will be considered defective if either does not pass required tests and inspections.
  - .3 Prepare test and inspection reports in accordance with requirements listed in NFPA 2001, Section "Installation Acceptance."

### 3.8 CLEANING

- .1 Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

### 3.9 OPERATIONAL CONDITION SYSTEM FILLING

- .1 Preparation:
  - .1 Verify that clean-agent fire-extinguishing system and protected enclosure have passed all required tests and inspections in accordance with NFPA 2001.
  - .2 Verify that clean-agent fire-extinguishing piping system installation is completed and cleaned.
  - .3 Verify complete enclosure integrity.
  - .4 Verify operation of ventilation and exhaust systems.
- .2 Filling Procedures:
  - .1 Fill clean-agent fire-extinguishing containers with extinguishing agent, and pressurize to indicated charging pressure.
  - .2 Install filled containers.
  - .3 Energize circuits.
  - .4 Adjust operating controls.

### 3.10 TRAINING

- .1 The fire protection contractor must plan and organize a training session of at least four hours for the building maintenance staff, in the presence of building owner or his representative.
- .2 The training session must include the normal operation, emergency procedures and maintenance of the system.

### 3.11 TESTING AND VERIFICATION

- .1 The verification of the fire alarm system must be done in accordance with Division 26.
- .2 The verification of the clean agent must be done in accordance with NFPA 2001 requirements.
- .3 The verification of the pre-action must be done in accordance with NFPA 13 requirements.
- .4 The general contractor shall be responsible for sealing and securing the protected spaces against agent loss and/or leakage during the 10-minutes "hold" period.
- .5 The clean agent system piping shall be pneumatically tested in a close circuit for a period of 10 minutes at 40 psi (2.8 bars). At the end of the 10 minutes, the pressure drop shall not exceed 20% of the test pressure. The pressure test can be omitted in the case where the total piping contains no more than one change in direction fitting between the storage cylinder and the discharge nozzle, and where all piping is physically checked for tightness.
- .6 A room pressurization test shall be conducted by the installing contractor in each protected space to determine the presence of openings which would affect the agent concentration levels. All testing shall be made in accordance with NFPA 2001, Annex C.
- .7 If the room pressurization testing indicates that openings exist which would result in leaks and/or loss of the extinguishing agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the general contractor, sub-contractor or agent. The installing contractor shall inspect all work to ascertain that the protected space(s) have been adequately and properly sealed.

- .8 Hydrostatic tests must be performed on the entire sprinkler piping system, as required by NFPA 13.
- .9 In addition to the standard hydrostatic test, an air pressure leakage test at 40 psi (2.8 bars) shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 1½ psi (0.1 bar) during the 24 hours shall be corrected.
- .10 A drain test using the auxiliary drain valve fully open (drain located on water supply side, deluge valve inlet) must be performed to verify that the water supply is adequate and to make sure that no back pressure in drain piping exists, which could affect the proper operation of the preaction system.
- .11 An air supply test must be performed, to confirm that normal air pressure in the sprinkler system can be restored within 30 minutes.

3.12 **DEMONSTRATION**

- .1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

3.13 **REPORT AND CERTIFICATE**

- .1 An inspection report and a certificate must be supplied by the fire protection contractor to the engineer, owner or owner's representative at the completion of the project. All tests results shall be duly registered in a booklet to be included with the inspection report.

END OF SECTION 21 22 00

**1** General

**1.1 SUMMARY**

- .1 Portable Fire Extinguishers
- .2 Fire Extinguisher Cabinets
- .3 Fire Extinguisher Wall Hooks and Brackets

**1.2 RELATED REQUIREMENTS**

- .1 Section 20 05 00 – Mechanical General Requirements

**1.3 REFERENCE STANDARDS**

- .1 FM - Factory Mutual System - Approval Guide.
- .2 NFPA 10 - Portable Fire Extinguishers.
- .3 ULC - Fire Protection Equipment Directory.

**1.4 SUBMITTALS**

- .1 Submit shop drawings and product data for each of the following:
  - .1 Portable fire extinguishers.
  - .2 Cabinets.

**1.5 QUALITY ASSURANCE**

- .1 Perform Work to NFPA 10.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

**1.6 REGULATORY REQUIREMENTS**

- .1 ULC listed and labelled.
- .2 Rated and identified in conformance with CAN/ULC S508, "Rating and Fire Testing of Fire Extinguishers".

**2** Products

**2.1 GENERAL**

- .1 Manufacturers
  - .1 National Fire Equipment Ltd.
  - .2 Wilson & Cousins
  - .3 Badger Fire Protection
  - .4 Kidde Fire Safety
  - .5 Strike First
- .2 All fire extinguishers shall be pressurized (stored pressure) rechargeable type, in accordance with NFPA 10, and ULC listed and labelled for the class of fires for which they are specified.
- .3 Each extinguisher shall be complete with:

- .1 A manufacturer's identification label indicating the extinguisher model number, rating, and operating instructions.
- .2 An anodized aluminum or chrome plated forged brass valve with positive squeeze grip on-off operation and a pull-pin safety lock.
- .3 Discharge hose with nozzle or horn and hose securing clip.

## 2.2 MULTI-PURPOSE DRY CHEMICAL (ABC)

- .1 5 lb (2.27 kg)
  - .1 Manufacturer: Strike First or equivalent
  - .2 Model No.: WBDL-ABC310LV.
  - .3 ULC Rating: minimum 3A:40BC
- .2 10 lb (4.54 kg)
  - .1 Manufacturer: Strike First or equivalent
  - .2 Model No.: WBDL-ABC10
  - .3 ULC Rating: minimum 6A:80BC

## 2.3 CARBON DIOXIDE (BC)

- .1 5 lb (2.3 kg)
  - .1 Manufacturer: Strike First or equivalent
  - .2 Model No.: WBSF-5CO2
  - .3 ULC Rating: minimum 10BC
- .2 10 lb (4.5 kg)
  - .1 Manufacturer: Strike First or equivalent
  - .2 Model No.: WBSF-10CO2
  - .3 ULC Rating: minimum 60BC

## 2.4 CABINETS

- .1 Fully Recessed
  - .1 5 lb (2.3 kg) extinguisher
    - .2 Recessed fire extinguisher cabinet, 8" x 17" x 5" (200 mm x 425 mm x 125 mm), constructed of 22ga. (0.76 mm) steel tub with a 16ga. (1.57 mm) steel door and trim with a 1/4" (6 mm) return frame, a full length semi concealed piano hinge and flush stainless steel door latch. Entire cabinet finished in baked enamel paint and glazed with 3/16" (5 mm) clear glass.
    - .2 Model No.: 102F
  - .3 10 lb (4.5 kg) extinguisher
    - .1 Recessed fire extinguisher cabinet, 10" x 30" x 8" (250 mm x 750 mm x 200 mm), constructed of 18ga. (1.19 mm) steel tub and 14ga. (2.0 mm) steel door and trim with 1/2" (13 mm) return frame, a full length semi-concealed piano hinge and flush stainless steel door latch. Front section to have a full 2" (51 mm) adjustment to wall. Entire cabinet finished in baked enamel paint and glazed with 3/16" (5 mm) clear glass.

- .2 Model No.: CE-950-2
- .3 Size: to accommodate specified extinguisher.
- .2 Semi-Recessed
  - .1 5 lb (2.3 kg) extinguisher.
    - .1 Semi-recessed fire extinguisher cabinet 8" x 17" x 5" (200 mm x 425 mm x 125 mm), constructed of 22ga. (0.76 mm) steel tub and 16ga. (1.57 mm) steel door and trim with 1" (25 mm) return frame, a full length semi-concealed piano hinge and flush stainless steel door latch. Entire cabinet finished in baked enamel paint and glazed with 3/16" (5 mm) clear glass.
    - .2 Model No.: 102RS
  - .2 10 lb (4.5 kg) extinguisher.
    - .1 Semi-recessed fire extinguisher cabinet 9" x 24" x 6" (225 mm x 600 mm x 150 mm), constructed of 22ga. (0.76 mm) steel tub and 16ga. (1.57 mm) steel door & trim with 2" (51 mm) return frame, a full length semi-concealed piano hinge and flush stainless steel door latch. Entire cabinet finished in baked enamel paint and glazed with 3/16" (5 mm) clear glass.
    - .2 Model No.: CE-950-3-2
  - .3 Size: to accommodate specified extinguisher

## 2.5 WALL HOOKS AND BRACKETS

- .1 Wall Hooks
  - .1 Type: DC 1-1/8"
    - .1 5 lb (2.3 kg) ABC and BC extinguisher: Model No. C160738
    - .2 10 lb (4.5 kg) ABC and BC extinguisher: Model No. C160752
  - .2 Type: CO<sub>2</sub>
    - .1 5 lb (2.3 kg) BC extinguisher: Model No. SF5WH
    - .2 10 lb (4.5 kg) BC extinguisher: Model No. SF1015WH
- .2 Brackets
  - .1 Standard Duty: 5 lb (2.3 kg) ABC extinguisher, Model No. UB5
  - .2 Medium Duty: 10 lb (4.5 kg) ABC extinguisher, Model No. UP10-MD

## 2.6 IDENTIFICATION

- .1 Identify extinguishers in accordance with the recommendations of NFPA No. 10 and CAN/ULC-S508.
- .2 Attach a tag or label to the extinguisher indicating the month and year of installation. Provide space for service dates.

## 3 Execution

### 3.1 INSTALLATION

- .1 Install to manufacturer's instructions.

- .2 Conform to NFPA 10.
- .3 Do not install extinguishers until after wall finishing work is complete. Contractor shall be responsible for all extinguishers until receipt of a Certificate of Substantial Performance of the Work.
- .4 Locate and secure cabinets plumb and level. Establish top of cabinet (inside horizontal surface) 65" (1675 mm) above finished floor.
- .5 Fire extinguishers having a gross weight not exceeding 18.14 kg (40 lb) shall be installed so that the top of the fire extinguisher is not more than 1.5 m (5.0 ft) above the floor.
- .6 In no case shall the clearance between the bottom of the fire extinguisher and the floor be less than 102 mm (4").
- .7 Unless otherwise shown or specified, locate cabinets so that the centerline is approximately 1200 mm (48") above the finished floor.
- .8 Locate fire extinguisher in cabinet as indicated.
- .9 Install with wall mounting bracket where not installed in cabinets.

### 3.2 APPLICATIONS

- .1 Provide fire extinguishers where indicated and in conformance with the Ontario Fire Code and NFPA 10.
- .2 Provide 5 lb (2.27 kg) in general areas (i.e., areas not listed below).
- .3 Provide 10 lb. (4.5 kg) multi-purpose extinguishers in mechanical rooms.
- .4 Provide 10 lb. (4.5 kg) carbon dioxide extinguishers in electrical rooms and communications rooms.
- .5 Provide 5 lb. (2.27 kg) multi-purpose extinguishers in each kitchenette.

**END OF SECTION**

1 GENERAL.

1.1 REFERENCE STANDARDS

.1 ANSI/ASME

- .1 ANSI/ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ANSI/ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .3 ANSI/AWS
- .4 ANSI/AWS A5.8M/A5.8, Filler Metals for Brazing and Braze Welding.

.2 ASTM International Inc.

- .1 ASTM A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- .2 ASTM A403 / A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- .3 ASTM A743/A743A, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
- .4 ASTM B16.9, Factory-Made Wrought Buttwelding Fittings.
- .5 ASTM B75 Standard Specification for Seamless Copper Tube
- .6 ASTM B88, Standard Specification for Seamless Copper Water Tube.
- .7 ASTM F492, Standard Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.
- .8 ASTM F876, Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
- .9 ASTM F877, Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems.
- .10 ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing.
- .11 ASTM F1969, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing.
- .12 ASTM F3226, Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems

.3 American Water Works Association (AWWA)

- .1 AWWA B-300, Hypochlorites.
- .2 AWWA, C900: Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

.4 Canadian Standards Association (CSA International)

- .1 CAN/CSA B64, Backflow Preventers and Vacuum Breakers
- .2 CAN/CSA B137.2: Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications.
- .3 CAN/CSA B137.3: Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications



- .4 CAN/CSA-B137.5 Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications
- .5 CAN/ CSA B356: Water Pressure Reducing Valves for Domestic Water Supply Systems
- .6 ASME A112.18.1/CSA B125.1-2012, Plumbing Supply Fittings
- .7 CAN/ULC-S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies
- .8 CAN/ULC-S115, Standard Method of Fire Tests of Firestop Systems
- .5 IAPMO
  - .1 IAPMO PS 117 Press and Nail Connections
- .6 ISO
  - .1 ISO 9001 Quality Management Systems
- .7 National Building Code 2015 (NBC)
- .8 National Sanitation Foundation (NSF International)
  - .1 NSF/ANSI 14, Plastics Piping System Components and Related Materials.
  - .2 NSF/ANSI 61, Drinking Water System Components – Health Effects.

## 1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Provide the manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit WHIMS MSDS – Materials Safety Data Sheets.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

## 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 PIPING AND FITTINGS

- .1 Ductile Iron: Centrifugally cast ductile iron to ANSI/AWWA C151/A21.51 complete with ANSI/AWWA C104/A21.4 cement lining, and ANSI/AWWA C105/A21.5 protective polyethylene film (minimum nominal thickness of 200 microns and minus tolerance with 10 percent). Fittings to be cement lined ductile-iron/cast-iron mechanical joint fittings to ANSI/AWWA C110/A21.10. Rubber gasket joints for cast-iron or ductile-iron water pipes shall conform to ANSI/AWWA C110/A21.11.
- .2 PVC – Gasket Joint: ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe and CSA certified fittings to CSA B137.2, CSA B137.3 and

AWWA C900, complete with gasket joints and a mechanical restraint collar for each thrust block required in accordance with Part 3 of this Section.

Acceptable Manufacturers

- .1 Ipex Inc. "BLUE BRUTE" Gasketed Pressure Pipe (Formerly Canron and Scepter)
- .2 Rehau "AQUALOC" Gasketed Pressure Pipe
- .3 NAPCO "COID" PVC Pressure Pipe (Formerly North American Pipe Corporation and Royal Pipe & Fittings)
- .3 Stainless Steel – Grooved Joint: Type 304/316 Schedule 10S, ASTM 312, factory or site roll grooved, ASTM A743. Complete with stainless steel grooved end fittings and unless otherwise specified stainless steel mechanical joint couplings with EPDM gaskets suitable for potable water service. Gaskets to be NSF 61 listed and rated for temperatures from -35°C to 121 °C (-30°F to 250°F).
  - .1 Acceptable Manufacturers
    - .1 Victaulic Style 489
    - .2 Gruvlok 7400SS
    - .3 Tyco Grinnell 472
    - .4 Shurjoint #SS-7
- .4 Stainless Steel – Welded Joint: Type 304/316 Schedule 10S, ASTM 312, mill or site beveled, complete with factory made seamless stainless steel, butt welding fittings to ASTM A403M & ASME B16.9, long sweep pattern wherever possible, and welded joints. For underground applications Schedule 40 piping shall be used in place of Schedule 10S and piping shall be wrapped in corrosion-resistant PVC pipe tape. PVC pipe tape shall be minimum 0.25 mm (10 mil) thick, suitable for direct burial, and resist corrosion (by means of water, salts, alkalis, dielectric contact, and soil acids), moisture, bacteria, fungus, abrasion and UV (sunlight).
- .5 Stainless Steel – Press Joint: Type 304/316 Schedule 10S, ASTM 312, mill or site beveled, complete with stainless steel press fittings conforming to the material, sizing, and performance requirements of ASTM F3226 and IAPMO PS 117. Sealing elements for pressing fittings shall be EPDM and shall be factory installed or supplied by fitting manufacturer. Press fittings shall feature a design leakage path, assuring leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. System to be listed to NSF/ANSI 61 and to be rated to a minimum of 200 psi.
  - .1 Acceptable Manufacturers
    - .1 Viega Llc. "MegaPress Stainless 316"
    - .2 Victaulic "Vic-Press for Stainless Steel"
- .6 Type "K" Soft Copper: 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.
- .7 Copper - Solder Joint: Type "L" hard drawn seamless copper to ASTM B88, complete with wrought copper solder joint pressure fittings, ANSI/ASME B16.22 or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18.
  - .1 Soldered joints made using 96-0.5-4 tin silver copper, 95-5 tin antimony, 96-6 tin silver, or 96-4 tin silver solder, conforming to ASTM B32 for pipes less than 100mm (4 in.).
  - .2 Brazing joints made using 80-15-5 copper silver phosphorus brazing rod, conforming to ANSI/AWS A5.8M/A5.8 for pipes 100mm (4 in.) and up.

- .8 Copper – Press Joint: Type “L” hard drawn seamless copper to ASTM B88, complete with wrought copper press fittings (ANSI/ASME B16.22) or cast copper alloy press fittings (ANSI/ASME B16.18) conforming to the performance criteria of IAPMO PS 117. Sealing elements for pressing fittings shall be EPDM and shall be factory installed or supplied by fitting manufacturer. Press fittings shall feature a design leakage path, assuring leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. System to be listed to NSF/ANSI 61 and to be rated to a minimum of 200 psi.
  - .1 Acceptable Manufacturers
    - .1 Viega Llc. “ProPress”
    - .2 Nibco Inc. “Press Fittings”
- .9 Copper - Grooved Joint: Type “L” hard drawn seamless copper to ASTM B88, complete with shop or site roll grooved ends. Grooved end fittings conforming to ASTM B75. Couplings to be designed with angle bolt pads to provide a rigid joint, sealed with an EPDM gasket suitable for potable water service. Gaskets rated for temperatures from -35°C to 121 °C (-30°F to 250°F). System to be listed to NSF/ANSI 61.
  - .1 Acceptable Manufactures
    - .1 Victaulic “Copper Connection” Style 606 of Style 607
    - .2 Gruvlok “RIGIDLITE” Fig. 7400
    - .3 Tyco Grinnell 672
    - .4 Shurjoint #C301
- .10 Potable-grade PEX:
  - .1 Tube Materials: Tube shall be cross-linked polyethylene (PEX) manufactured by PEX-a or peroxide method.
    - .1 PEX tubing shall be ASTM F876 tested and approved for excessive temperature and pressure for 725 hours at 210°F (99°C) @ 1035 kPa (150 psi).
    - .2 PEX tubing shall be manufactured in accordance with ASTM F876, ASTM F877 and CAN/CSA-B137.5. The tube shall be listed to ASTM by an independent third party agency.
    - .3 PEX tubing shall be listed to both NSF/ANSI 14 and 61.
    - .4 PEX tubing shall have Standard Grade hydrostatic design and pressure ratings of 82°C (200°F) at 551 kPa (80 psi), 82°C (180°F) at 689 kPa (100 psi), and 23°C (73.4°F) at 1102 kPa (160 psi). Temperature and pressure ratings shall be issued by the Plastic Pipe Institute (PPI), a division of the Society of the Plastic Industry (SPI).
    - .5 Minimum bend radius for cold bending of the PEX tubing shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by tube manufacturer.
  - .2 PEX tube dimensions 12 mm (½ in.) to 25mm (1 in.) shall be in accordance with ASTM F876 and ASTM F877.
  - .3 When used in buildings of non-combustible construction all PEX tubing shall be listed to CAN/ULC S102.2, achieving a Flame Spread Rating not exceeding 25 and achieving a Smoke Developed Classification not exceeding 50. All conditions required to meet the listing shall be strictly adhered to (eg. minimum 457 mm (18 in.) spacing between PEX runs). The PEX tubing shall meet the Flame Spread Rating and Smoke Developed Classification as an independent component, using an addition component/material to meet these requirements is unacceptable (eg. plenum

wrap, insulation, water-filled pipe, etc.). All firestops shall be approved by CAN/ULC-S115.

- .4 Pre-Sleeved Tubing: All PEX tubing that is encased in concrete or buried underground shall be pre-sleeved in corrugated polyethylene tubing.
- .5 Fitting Materials: Fittings, including manifolds and multi-port tees, shall be manufactured of Engineered Polymer (EP). Stainless steel materials are allowed only for transition fittings. Fitting connections shall be made to the requirements of ASTM F1960.
- .6 Fittings shall be supplied by the PEX tubing manufacturer.
- .7 PEX-a cold expansion type fittings shall be an assembly consisting of insert and PEX-a cold expansion ring.
- .8 Acceptable Manufacturers:
  - .1 UPONOR Ltd. (Wirsbro)
  - .2 REHAU Group
  - .3 AQUATHERM
  - .4 PERMA-PIPE, Inc.

### 3 EXECUTION

#### 3.1 PIPING MATERIALS AND JOINT TYPES

- .1 Above grade piping, unless otherwise specified, is to be as follows:
  - .1 Domestic water, 25 mm (1 in.) and smaller, less than 1380 kPa (200 psi) working pressure:
    - .1 "Copper - Solder Joint" piping shall be used.
    - .2 Alternatively "Copper - Press Joint" piping may be used.
    - .3 Where permitted by local building code/AHJ and when working pressures are below 1034 kPa (150 psi) "Potable-grade PEX" piping may be used as an acceptable alternative for trap priming lines or undergrounds runs to non-freeze wall hydrants (NFWHs) along perimeter of building (runs to NFWHs shall be installed in HDPE sleeve to allow for removal and replacement of the tubing if required).
  - .2 Domestic water, larger than 25 mm (1 in.) up to and including 75mm (3 in.), less than 1380 kPa (200 psi) working pressure:
    - .1 Shall use Copper - Solder Joint piping.
    - .2 Alternatively "Copper - Press Joint", "Copper – Grooved Joint", "Stainless Steel – Grooved Joint", "Stainless Steel – Welded Joint", or "Stainless Steel – Press Joint" piping may be used.
  - .3 Domestic water, 100 mm (4 in.), less than 1380 kPa (200 psi) working pressure:
    - .1 Shall use Copper – Grooved Joint piping.
    - .2 Alternatively "Copper – Solder Joint", "Copper - Press Joint", "Stainless Steel – Grooved Joint", "Stainless Steel – Welded Joint", or "Stainless Steel – Press Joint" piping may be used.
  - .4 Domestic water, 150mm (6 in.) and larger, less than 1380 kPa (200 psi) working pressure:

- .1 Shall use Stainless Steel – Grooved Joint piping.
- .2 Alternatively, “Stainless Steel – Welded Joint”, or “Stainless Steel – Press Joint” piping may be used.
- .2 Underground piping, unless otherwise specified, is to be as follows:
  - .1 Domestic water, 75 mm (3 in.) and smaller within building footprint and to points outside the building lines shall use Type “K” Soft Copper piping, alternatively Potable-grade PEX piping designed for underground installation may be used. All non-metallic piping shall be changed to metallic piping prior to entering the building.
  - .2 Domestic water, 100 mm (4 in.) and larger within the building footprint and to points outside the building lines shall use PVC – Gasket Joint piping except for transition into building which shall be “Ductile Iron” or “Stainless Steel – Welded Joint”.
  - .3 All non-metallic piping shall be changed to metallic piping prior to entering the building using an EBAA Iron Inc. Mega-Coupling Series 3800 Restrained Coupling or acceptable equivalent. (i.e., changed before passing through basement floor or slab on grade). Acceptable Manufacturers:
    - .1 EBAA Iron Inc.
    - .2 Krawusz Industries Ltd. (Hymax)
    - .3 The Ford Meter Box Company

### 3.2 GENERAL PIPING INSTALLATION REQUIREMENTS

- .1 Provide all required potable water piping.
- .2 Slope all piping so that it can be completely drained
- .3 Unless otherwise specified in the Contract Documents, locate and arrange horizontal pipes above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained.
- .4 Unless otherwise specified in the Contract Documents, install all work concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Note that walls which are painted are considered finished.
- .5 Install all pipes and ducts parallel to building lines (all piping shall run parallel with closest wall).
- .6 Piping in walk-in pipe spaces shall be installed as close to one wall as possible.
- .7 Neatly group and arrange all exposed Work.
- .8 Locate all valves and any other equipment which will or may need maintenance or repaired in accessible spaces, equipment shall be easily accessible from access doors. Where valves and similar piping accessories occur in vertical service spaces (ie. in shafts, pipe spaces or partitions) locate the accessories at the floor level.
- .9 Make all connections between pipes of different materials using proper approved adapters. Provide proper dielectric unions in all connections between copper pipe and ferrous pipe or equipment. Dielectric fitting to conform to ASTM F492 complete with thermoplastic liner.
- .10 Ensure that the equipment and material manufacturers' installation instructions are followed unless otherwise specified in this Section or on the Drawings, and unless such instructions contradict governing codes and regulations.
- .11 Carefully clean all pipes and fittings prior to installation. Temporarily cap or plug ends of pipes and equipment which are open and exposed during construction.

- .12 Install piping which is to be insulated so that they have sufficient clearance to permit insulation to be applied continuously and unbroken around the pipe, except at fire barriers, in which case the insulation will be terminated at each side of the fire barrier.
- .13 Inspect surfaces and structure prepared by other trades before performing the work of this Section. Verify that surfaces or the structure to receive the work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing to the Consultant. Installation of the work shall constitute the Contractor's acceptance of such surfaces as being satisfactory.

### 3.3 UNDERGROUND PIPING INSTALLATION REQUIREMENTS

- .1 The following publications shall be used to establish class of bedding and class of piping for installation other than the above. They shall also serve as guide for preparation of bedding, installation and testing.
- .2 The Blue Brute installation Guide by Johns-Manville.
- .3 Pipe passing under a driveway or parking lot with less than 1.5 m (5 ft.) of cover shall be encased in 150 mm (6 in.) of 13,800 kPa (2000 psi) concrete on top, bottom and sides.
- .4 Provide thrust blocks of 20 MPa (3000 psi) concrete at each tee, elbow, valve and other fitting where thrust forces could occur. Thrust blocks shall be sized to suit the local authorities requirements, but in no case be smaller than 150 mm (6 in.) greater on all sides than the pipe served.
- .5 Tracer Wire for PVC and PEX U/G Pipe (excluding trap priming lines and pipes installed in a secondary containment tube allowing for complete pipe replacement from above grade): Prior to backfilling, secure light coloured plastic insulated #10 ga. TW solid copper wire or seven strand insulated copper wire to the top of all buried PVC and PEX pipes secured to the top of the pipe with plastic type ties for the entire length of the pipe for pipe location tracing purposes. Terminate in a round or square non-metallic PVC floor box, flush mounted with a brass cover plate. Coil 450 mm (18 inches) of wire inside box.
- .6 Lay pipes true to line and grade with bells up grade. Fit sections together so that, when complete, the pipe has a smooth and uniform invert. Keep pipe thoroughly clean so that jointed compound will adhere. Inspect the pipe for defects before being lowered into the trench. Do not use defective pipe.

### 3.4 PIPE JOINT REQUIREMENTS

- .1 For pipes travelling perpendicular (through) walls or slabs do not make pipe joints inside the wall or slab. Pipe joints can be made inside a wall while the pipe is travelling parallel to the wall, concealed inside.
- .2 Ream all piping ends prior to making joints.
- .3 Properly cut threads in screwed steel piping and coat male threads, unless otherwise specified in the Contract Documents, with red lead, Teflon tape or paste, or an equivalent thread lubricant. After the pipe has been screwed into the fitting, valve, union, or piping accessory, not more than two pipe threads are to remain exposed.
- .4 Unless otherwise specified in the Contract Documents, make all soldered joints in copper piping using flux suitable for and compatible with the type of solder being used. Clean the outside of the pipe end and the inside of the fitting, valve, or similar accessory prior to soldering.
- .5 Install mechanical joint fittings and couplings in accordance with the manufacturer's instructions.

- .6 If grooved fittings and couplings are used, ensure that all valves and piping accessories are suitable. Grooves shall be rolled. Make arrangements with the coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to the manufacturer's instructions with respect to pipe grooving, support, anchoring and guiding the grooved piping system. Note that all grooved end piping system products shall be supplied by a single manufacturer who is operating to an ISO 9001 program.

### 3.5 PRESSURE TESTS

- .1 Conform to requirements of Section 20 05 00 – General Mechanical Requirements.
- .2 Test pressure: Shall be the larger value of 150% maximum system operating pressure or 860 kPa.

**END OF SECTION 22 11 16**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Testing and Materials (ASTM)
  - .1 ASTM A743/A743A, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
- .2 American Water Works Association (AWWA)
  - .1 AWWA C701, Cold Water Meters – Turbine Type
  - .2 AWWA C702, Cold Water Meters – Compound Type
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA B64, Backflow Preventers and Vacuum Breakers
  - .2 CAN/ CSA B356: Water Pressure Reducing Valves for Domestic Water Supply Systems
  - .3 ASME A112.18.1/CSA B125.1-2012, Plumbing Supply Fittings
- .4 National Sanitation Foundation (NSF International)
  - .1 NSF/ANSI 61, Drinking Water System Components – Health Effects
  - .2 NSF/ANSI 372, Drinking Water System Components – Lead Content
- .5 National Building Code

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
  - .1 Provide the manufacturer's printed product literature and datasheets for equipment, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 SHUT-OFF VALVES

- .1 Ball Valves: Lead Free Class 600, 4140 kPa (600 psi) WOG rated full port ball type valves, each complete with a forged brass or bronze body with solder ends, forged brass cap and blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle. Where piping is insulated provide stem extensions to clear insulation. Acceptable products are:
  - .1 Kitz Corporation Code No. 859.



- .2 Toyo Valve Co. Fig. 5049ALF.
- .3 MAS B-4LF.
- .4 Nibco #S-585-80LF (Bronze).
- .5 Watts Water Technologies (Canada), Inc. #LF6080, LFB6081-3C.
- .2 Butterfly Valves – Lead Free, Flanged Joint: Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated butterfly valves, each complete with a coated cast iron or ductile iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for potable water bubble-tight dead end service with the valve in position and either side of the connecting piping removed. Butterfly valves to and including 100 mm (4 inch) diameter are to be equipped with lever handles. Butterfly valves larger than 100 mm (4 inch) diameter are to be equipped with worm gear operators. Where piping is insulated provide stem extensions to clear insulation. Acceptable products are:
  - .1 Apollo #LC149 Series.
  - .2 DeZurik #BOS-CL Series.
  - .3 Nibco Series LD-2000.
  - .4 MAS #LD4-A-E.
- .3 Butterfly Valve – Grooved Joint Copper Piping: Victaulic Co. of Canada Series 608 “COPPER CONNECTION”, Tyco Grinnell B680, or Shurjoint Model SJ-C300, 2065 kPa (300 psi) rated butterfly valves, each complete with a cast bronze body with grooved ends, resilient elastomeric coating bonded to a ductile iron disc suitable for potable water, bubble tight shut-off, and manual lever handle. Where piping is insulated provide stem extensions to clear insulation.

## 2.2 CHECK VALVES

- .1 Horizontal: Lead Free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends. Acceptable products are:
  - .1 Kitz Corporation Code No. 823.
  - .2 Nibco #S-413-Y-LF.
  - .3 Toyo #237A-LF
  - .4 Watts Water Technologies (Canada), Inc. #LF600 up to 50 mm (2 inch)
- .2 Vertical: Lead Free, Bronze, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends. Acceptable products are:
  - .1 Kitz Corporation Code No. 826.
  - .2 Nibco #S-480-Y-LF.

## 2.3 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm (3/4-inch) diameter straight pattern bronze or brass ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (3/4-inch) diameter garden hose, and a cap and chain. Where piping is insulated provide stem extensions to clear insulation. Acceptable products are:
  - .1 Kitz Corporation Code 869 C/868 AC.
  - .2 Apollo #70-LF-100/200-HC.
  - .3 Nibco #S-585-80-LF.
  - .4 Toyo #5046-LF.

## 2.4 UTILITY WATER METER

- .1 75mm (3 in.) Sensus (Xylem Inc.) "OMNI Compound (C2)" water meter or approved equivalent tamper-proof, in line serviceable meter suitable for connection of a remote automatic reading and billing unit. Meter shall be in accordance with AWWA Standard C701 and C702 and complete with:
  - .1 Cast iron main case.
  - .2 Stainless steel strainer with removable cover for maintenance access.
  - .3 A roll-sealed magnetic drive register, and a turbine measuring element.
  - .4 A surface wall mounting automatic meter reading and billing unit with encoder register, polycarbonate housing, roll-sealed copper shell, and ABS plastic receptacle.

## 2.5 SUB-WATER METER

- .1 For pipe sizes up to 50mm (2 in.): Neptune Technology Group (Canada) Limited "T-10 Meter" or approved equivalent tamper-proof, in line serviceable meter suitable for connection of a remote automatic reading and billing unit and complete with:
  - .1 Cast bronze main case.
  - .2 Roll sealed register, and positive displacement rotating disc measuring chamber.
  - .3 An "ARB-V" surface wall mounting automatic meter reading and billing unit with encoder register, polycarbonate housing, roll-sealed copper shell, and ABS plastic receptacle.
- .2 For pipe sizes 75mm (3 in.) and larger: Neptune Technology Group (Canada) Limited "HP Turbine Meter" or approved equivalent tamper-proof, in-line serviceable meter suitable for connection of a remote automatic reading and billing unit and complete with:
  - .1 A cast bronze main case.
  - .2 A turbine measuring element.
  - .3 An "ARB-V" surface wall mounting automatic meter reading and billing unit with encoder register, polycarbonate housing, roll-sealed copper shell, and ABS plastic receptacle.

## 2.6 POTABLE HOT WATER AUTOMATIC FLOW LIMITING & BALANCING VALVES

- .1 Brass, Solder end type, lead free, automatic flow limiting valve, valves designed to facilitate precise flow balancing of potable hot water. Operating pressure between 2 to 80 psi. Operating temperature range between 32F to 212F. Complete with changeable GPM flow cartridges, EPDM O-Ring and diaphragm, Polyphenylsulfone orifice and certified to NSF/ANSI 61 & 372. Acceptable products are:
  - .1 Caleffi AutoFlow 127 Series.
  - .2 Hays Fluid Controls Model 2517LF.
- .2 Solder end type, globe style, non-ferrous circuit balancing valves designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with valved ports for connection to a differential pressure meter. Certified to NSF/ANSI 61 & 372. Acceptable products are:
  - .1 Armstrong Fluid Technology Model CBV-S.
  - .2 Tour and Anderson Model TBV-S or STAD/STAS.
  - .3 RWV #9519AB.

## 2.7 INTERIOR HOSE BIBBS

- .1 'HB-1' Exposed – Cold Water: Cast bronze hose bibb with hose end vacuum breaker. Acceptable products are:

- .1 Zurn #Z1341.
- .2 Watts Water Technologies (Canada), Inc. #SC8-1.
- .3 Jay R. Smith #5673
- .4 Mifab #MHY-90.
- .2 'HB-2' Exposed – Hot & Cold Water: Rough Brass hose bibb with 19mm hose end complete with built-in vacuum breaker with aluminum handles. Wall thickness to suit application. Acceptable products are:
  - .1 Woodford Model 22

## 2.8 EXTERIOR NON-FREEZE WALL HYDRANTS

- .1 Concealed and recessed, non-freeze, key operated, lead free wall hydrant. Each hydrant shall be complete with a nickel bronze box and door, vacuum breaker, 20 mm (3/4 in.) diameter threaded hose connection, 20 mm (3/4 in.) female x 25 mm (1 in.) male pipe connection, all bronze head, seat casting and internal working parts, bronze wall casing and loose operating key. Acceptable products are:
  - .1 Zurn #Z1300.
  - .2 Watts Water Technologies (Canada), Inc. #HY-725
  - .3 Jay R. Smith #5509QT.
  - .4 Mifab #MHY-20.

## 2.9 NON-FREEZE ROOF HYDRANT

- .1 Watts HY-900 Hydrant - Non-Freeze roof Hydrant, epoxy coated cast iron, lift handle, valve housing, galvanized casing, with lock option, 1/8" NPT drain port, integral roof mounting plate, epoxy coated cast iron, clamping collar.

## 2.10 VACUUM BREAKERS

- .1 Threaded brass or bronze lead free 20 mm (3/4-inch) diameter hose connection vacuum breakers to CSA B64, each designed to connect to the hose bibb inlet and to be non-removable when in place. Watts Water Technologies (Canada), Inc. LF8 or acceptable equivalent.

## 2.11 FLOOR DRAIN TRAP SEAL PRIMERS

- .1 Pressure Drop Activated (3 PSI):
  - .1 Mifab Manufacturing, Inc. Model M2-500, 20.7 kPa (3 psi) pressure drop activated trap seal primer, constructed of brass, non-adjustable serviceable sediment filter, 12 mm (1/2 inch) threaded inlet and outlet connections, for priming up to four traps from the same primer, and c/w a MI-DU-2 distribution unit.
  - .2 Mifab Manufacturing Inc. Model M1-500, 20.7 kPa (3 psi) pressure drop activated trap seal primer, constructed of brass, non-adjustable serviceable sediment filter, 12 mm (1/2 inch) threaded inlet and outlet connections, c/w a Model MI-DU distribution unit for priming 2, 3 or 4 traps and an additional 2 more MI-DU distribution units for priming 5 to 10 traps. Additional distribution units to be installed in a pyramid fashion with the two additional distribution units being fed from a primary distribution unit.
- .2 Pressure Drop Activated (10 PSI):
  - .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 (1/2 inch) threaded inlet and outlet connections, and, for priming two traps from the same primer, a DU-2 dual outlet distribution unit.

- .2 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 8 traps.
- .3 Electronic Primer:
  - .1 Precision Plumbing Products "PT Prime Time" Series, recessed or surface mount, 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:
    - .2 Cabinet:
      - .1 Recessed Cabinet: In finished areas provide a galvanized steel NEMA-1 cabinet complete with hinged door or cover plate.
      - .2 Surface Mount Cabinet: In unfinished areas (Janitor Rooms, Mechanical Rooms, etc.) provide a powder coated steel NEMA-1 cabinet complete with hinged door or cover plate.
  - .3 20 mm (3/4-inch) diameter NPT copper pipe inlet with shut-off valve and water hammer arrestor.
  - .4 A solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm (1/2-inch) diameter compression type copper tube connections on 40 mm (1-1/2 inch) centres with quantity to suit the number of items to be primed.
  - .5 A control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

## 2.12 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 the kinetic energy generated in the piping system, and each sized to suit the connecting potable water pipe and equipment it is provided for. Acceptable products are:
  - .1 Zurn #Z1700 "SHOKTROL".
  - .2 Precision Plumbing Products (PPP) "SS" Series.
  - .3 Jay R. Smith 5000 Series "HYDROTROL".
  - .4 Mifab "HAMMERGUARD" WHB Series.
  - .5 Watts Water Technologies (Canada), Inc. SS Series.

## 2.13 BACKFLOW PREVENTERS

- .1 Reduced pressure zone dual check valve design lead free backflow preventers in accordance with CSA B64, each of bronze or epoxy coated cast iron bronze fitted construction depending on size, and complete with inlet strainer, inlet and outlet shut-off valves, an intermediate relief valve, ball valve type test cocks, and a proper air gap fitting. Acceptable products are:
  - .1 Watts Water Technologies #LF009QT for 12 mm (1/2-inch) size and #LF909QT for 20 mm to 50 mm (3/4-inch to 2 inch) size.
  - .2 Watts Water Technologies 957 or 994 series for 65 mm to 250 mm (2-1/2 inch to 10 inch) size (stainless steel).
  - .3 Zurn/Wilkins #375 for 20 mm to 50 mm (3/4-inch to 2 inch) size
  - .4 Zurn/Wilkins #375AST series for 65 mm to 250 mm (2-1/2 inch to 10 inch) size.

- .5 Conbraco Industries Inc. Series 40-200 for 12 mm to 50 mm (1/2-inch to 2 inch) size.
- .6 Conbraco Industries Inc. Series 4A-200 LBF or 4AN-200LBF (stainless steel) 65 mm to 250 mm (2-1/2 inch to 10 inch) size.
- .7 Ames Model LF2000B for 12 mm to 50 mm (1/2-inch to 2 inch) size.
- .8 Ames Model 4000SS (stainless steel) for 65 mm to 250 mm (2-1/2 inch to 10 inch) size.

#### 2.14 PIPING "V-LOOP" EXPANSION COMPENSATORS

- .1 Piping and equipment connections shall be protected against seismic damage by the insertion of braided flexible hose.
- .2 Vee assemblies shall be rated for  $\pm 4"$  (100mm) seismic motion in all planes. Should the application include  $\pm 6"$  (150mm) thermal movement or thermal movement alone, install the Vee so the thermal movement is axial.
- .3 All submittals shall include a recognized test report, covering the full range of the specified movements at the operating pressures.
- .4 Vees shall have a minimum burst pressure of four times their rated pressure.
- .5 Vees in steel lines shall have stainless hose and braid with threaded ends, weld ends or floating flanges. In stainless lines, all fittings in contact with the media must be stainless as well. Copper lines, bronze hose and braid with copper or bronze fittings. Guiding and anchoring shall be as designed by the manufacturer, stamped by a Professional Engineer and included with the submittals.
- .6 Acceptable products are:
  - .1 Manson Industries Inc, Vee Assembly.
  - .2 Hyspan Precision Products, Series 4500 V-flex.
  - .3 Metraflex, Metraloop V-loop.

#### 2.15 POTABLE THERMOSTATIC MIXING VALVES

- .1 Rough bronze lead free thermostatic mixing valve assemblies, each complete with ball type shut-off valves, pressure regulating valve, angle check stops, and dial type thermometer. Provide dual thermostatic mixing valves as necessary to allow for a minimum flow of 0.06 L/s (1 gpm). In finished areas mount the mixing valve in a recessed or a surface wall mounted stainless steel cabinet complete with a plexi-glass window in door. In unfinished areas (Janitor Rooms, Mechanical Rooms, etc.) no cabinet is required. Locations and cabinet style as shown on Drawings. Expand pipe to sizes as shown on Drawings before and after exiting the mixing valve:
  - .1 Individual fixture thermostatic valves to be sized by fixture manufacturer.
- .2 Acceptable manufacturers are:
  - .1 Leonard Valve Company.
  - .2 Lawler Manufacturing Co, Inc.
  - .3 Powers (Watts Water Technologies Company).
  - .4 Symmons Industries, Inc.
  - .5 Acorn Engineering Company.

#### 2.16 FLEXIBLE PUMP CONNETIONS

- .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. NSF 372 Lead Free.  
Acceptable products are:

- .1 Metraflex Company. Flexible metal hose.
- .2 Thorburn Equipment Inc. corrugated metal hose
- .3 Senior Flexonics Inc. A1 and A6 Series

## 2.17 PEX SYSTEM ACCESSORIES

- .1 Fixture Shut-Off Valves: Fixture Shut-Off valves shall be supplied by the PEX tubing manufacturer.
- .2 Tubing Wall Penetration Brackets: Brackets designed for tubing wall membrane penetrations shall be supplied by PEX tubing manufacturer.

## 2.18 PRESSURE REDUCING VALVES:

- .1 For piping to and including 50 mm (2 inch) diameter, non-corrosive, non-ferrous direct spring acting pressure reducing valves to CSA B356, each factory set at 345 kPa (50 psi) unless otherwise specified or required, each field adjustable from 175 kPa to 520 kPa (25 psi to 75 psi) and each complete with an integral inlet strainer. Acceptable products are:
  - .1 Conbraco 36 Series.
  - .2 Zurn/Wilkins 600 Series.
  - .3 Watts Water Technologies (Canada), Inc. LF25AUB-Z3.
  - .4 Cash-Acme EB-86U Series.
- .2 For piping 75 mm (3 inch) diameter and larger, non-corrosive pilot operated pressure reducing valve to CSA B356, factory set at the required pressure, field adjustable, and complete with a coated cast iron or ductile iron body and trim, screwed or flanged connections, and brass body pilot valve with stainless steel seat. Acceptable products are:
  - .1 Singer Valve Model 106 PR.
  - .2 Zurn/Wilkins Model ZW209.
  - .3 Watts Water Technologies (Canada), Inc. Model F115-150 and Model 300 (flanged), PV10M/T.

## 2.19 STRAINERS

- .1 For pipe diameters 65 mm (2.5 inch) and below: Lead Free, Class 125, 1380 kPa (200 psi) WOG rated, certified to NSF/ANSI/CAN 61. Main body and access cover shall be bronze or copper silicon alloy. The strainer screen shall be 300 series stainless steel and available in 20 mesh. Screens shall be accessible for cleaning without removing the device from the line. Acceptable products are:
  - .1 Zurn/Wilkins Model SXL or YBX
  - .2 Watts Water Technologies Series LF777 or LFS777
  - .3 Mueller LF351, LF352
- .2 For pipe diameters 75 mm (3 inch) and above: Lead Free, Class 125, 1380 kPa (200 psi) WOG rated, certified to NSF/ANSI/CAN 61. The main body and access cover shall be ductile iron complete with an NSF/ANSI/CAN 61 certified Fusion Epoxy Finish coating inside and out. The strainer screen shall be 300 series stainless steel and available in 20 mesh. Screens shall be accessible for cleaning without removing the device from the line. Acceptable products are:
  - .1 Zurn/Wilkins Model FSC

- .2 Watts Water Technologies Series 77F-DI
- .3 MAS W40-A-YX-FF

### 3 EXECUTION

#### 3.1 INSTALLATION OF SHUTT-OFF AND CHECK VALVES

- .1 Provide shut-off valves on each branch to each piece of equipment, fixtures and wherever else indicated on Drawings.
- .2 Provide check valves on pump discharge and wherever else indicated on Drawings.

#### 3.2 INSTALLATION OF DRAIN VALVES

- .1 Provide a drain valve at the bottom of potable water piping risers and at all other piping low points.
- .2 Locate drain valves so that they are easily accessible.

#### 3.3 INSTALLATION OF UTILITY WATER METER

- .1 Provide the potable water service meter where shown. Secure the meter in place on a concrete housekeeping pad and connect with piping as indicated, including a three-valve bypass.
- .2 Provide and install all other hardware necessary to connect to utility.
- .3 Connect all meter to BAS for metering; provide all wiring and BACnet gateway.

#### 3.4 INSTALLATION OF WATER SUB-METERS

- .1 Provide potable water service meter(s) where shown on Drawings. Secure the meter in place and connect with piping as indicated, including shut off valves upstream and downstream of the meter for servicing.
- .2 Connect all meters to BAS for remote metering; provide all wiring and BACnet gateways.

#### 3.5 INSTALLATION OF AUTOMATIC FLOW LIMITING & BALANCING VALVES

- .1 Provide balancing valve(s) in potable hot water recirculation piping where shown.
- .2 Locate each valve such that it is easily accessible.

#### 3.6 INSTALLATION OF HOSE BIBBS

- .1 Provide hose bibs where shown and/or specified on the Drawings.
- .2 Unless otherwise shown, specified or required, mount hose bibs approximately 915 mm (3 feet) above the floor. Confirm exact locations prior to roughing-in.

#### 3.7 INSTALLATION OF EXTERIOR NON-FREEZE WALL HYDRANTS

- .1 Provide non-freeze wall hydrants where shown.
- .2 Install hydrants level and plumb such that hose outlets are approximately 600 mm (2 feet) above grade level. Confirm exact locations prior to roughing-in.

#### 3.8 INSTALLATION OF VACUUM BREAKERS

- .1 Provide a vacuum breaker for each potable water hose bibb that is not factory equipped with an integral vacuum breaker.

#### 3.9 INSTALLATION OF TRAP SEAL PRIMERS

- .1 Provide accessible trap seal primers to automatically maintain a water seal in floor drain traps. Install in accordance with the manufacturer's instructions and details.

- .2 Connect each trap seal primer inlet with Type "L" hard copper tubing off the top of the nearest available potable water piping to plumbing fixtures or equipment.
- .3 Where multiple traps (3 to 8) are to be primed by a single primer valve, provide distribution unit(s) and, where required, a supply tube. Wall mount level and plumb, and provide a clear plastic cover.
- .4 In mechanical rooms, garage areas, and vestibules (remote locations) provide 115 volt, electronic, surface wall mounting trap primer assemblies for multiple traps (1 to 30) and wherever else indicated. Include for a 115 volt, 15 ampere circuit to each assembly extended from the nearest suitable panelboard and with wiring in conduit to the standards of Division 26.
- .5 Above grade provide 12 mm (1/2-inch) Type "L" copper piping to each trap. Exposed piping is to be hard drawn. Concealed piping is to be soft.
- .6 Below grade and concrete embedded provide 12 mm (1/2-inch) high density polyethylene tubing to each trap.

### 3.10 INSTALLATION OF SHOCK ABSORBERS

- .1 Provide accessible shock absorbers in potable water piping at groups of plumbing fixtures, at the top of risers as required to prevent piping water hammer.
- .2 Ensure that the size of each shock absorber is properly selected to suit the size of the potable water pipe and the equipment of the pipe is connected to.
- .3 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with the manufacturer's published instructions and details.

### 3.11 INSTALLATION OF BACKFLOW PREVENTERS

- .1 Provide a backflow preventer in each direct potable cold water connection to equipment other than plumbing fixtures and fittings. Equipment may be grouped (or zoned) together using a single backflow preventer if permissible by the applicable plumbing code and CSA B64.1
- .2 Locate each backflow preventer such that it is easily accessible for maintenance and testing. Equip each backflow preventer with an air gap fitting and pipe the reduced pressure zone water outlet to drain.
- .3 Install and test backflow preventer in accordance with CSA B64.

### 3.12 INSTALLATION OF PIPING "V-LOOP" EXPANSION COMPENSATORS

- .1 Provide expansion compensators in potable water piping at building expansion joints and where shown on Drawings.
- .2 Ensure that pipe ends are properly aligned. Provide alignment guides where shown, and anchor piping where indicated by means of anchors supplied by the expansion compensator manufacturer or by means of approved site fabricated anchors.

### 3.13 INSTALLATION OF THERMOSTATIC MIXING VALVES

- .1 Provide a potable hot water thermostatic mixing valve assembly where shown on Drawings 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 plate.

### 3.14 INSTALLATION OF PRESSURE REDUCING VALVE

- .1 Provide potable water pressure reducing valves in piping where shown. Install so that each valve is readily accessible. Whenever possible, provide pressure reducing valves factory preset to required pressures.



- .2 Provide a pressure gauge [in accordance with Section 20 05 19] in piping at each side of each pressure reducing valve. Check and test operation and adjust as required.

### 3.15 INSTALLATION OF STRAINERS

- .1 In lieu of integral potable water strainers, separate potable water strainers may be provided for pressure reducing valves, backflow preventers, and water meters.
- .2 Provide potable water strainers wherever shown contractor documents or for equipment where sediments could cause premature failure (refer to written manufacturer installation instructions or recommendations).

**END OF SECTION 22 11 19**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 ASTM International Inc.
  - .1 ASTM B306, Standard Specification for Copper Drainage Tube (DWV).
- .2 American Water Works Association (AWWA)
  - .1 ANSI/AWWA C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast
  - .2 ANSI/AWWA C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
  - .3 ANSI/AWWA C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems
  - .4 ANSI/AWWA C110/A21.10, Ductile-Iron and Gray-Iron Fittings
  - .5 ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA B70, Cast iron soil pipe, fittings, and means of joining.
  - .2 CAN/CSA B602, Mechanical couplings for drain, waste, and vent and sewer pipe.
  - .3 CAN/CSA B182.2, PSM Type Polyvinylchloride (PVC) Sewer Pipe and Fittings.
- .4 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC S102.2, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 ULC/CAN4-S115-M85 Standard Method of Fire Tests of Firestop Systems
- .5 Globally Harmonized System of Classification and Labelling of Chemicals (GHS)
  - .1 Material Safety Data Sheets (MSDS).
- .6 National Building Code 2015 (NBC)

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
  - .1 Submit shop drawings for all products specified in this Section except pipe and fittings. Shop drawings are to include all components including but not limited to panel layout drawings, wiring diagrams with wire numbers, individual components within panel, motor shop drawing, etc.
  - .2 Contractor shall provide vent piping in accordance with NBC/NPC and local bylaws. Submit plumbing vent piping sizing/ calculations and vent piping layout drawings shop drawings for all buildings. Shop drawings are to include all components including but not limited to layout drawings, vent terminations, installation details.
- .3 Test Data: Submit the following test data prior to application for Substantial Performance of the Work.
  - .1 Pipe leakage test sheets in accordance with Section 20 05 00 – General Mechanical Requirements.
  - .2 A copy of the plumbing inspection certificate.
  - .3 Any other start-up or test data specified in this Section.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

**2 PRODUCTS**

**2.1 PIPE, FITTINGS AND JOINTS**

- .1 Adhesives and Sealants: Use sealants as recommended by the Manufacturer, in accordance with Section 01 60 00 – Product Requirements as well as relevant ASTM standards.

**2.2 PIPING AND FITTINGS**

- .1 Solvent Weld PVC Sewer Pipe: SDR 35, 100 mm (4") and below, rigid PVC hub and spigot pattern sewer pipe and fittings in accordance with CAN/CSA B182.2. Solvent weld cement and primer (when required by manufacture) shall be same manufacturer as pipe.
  - .1 Acceptable Manufacturers
    - .1 Ipex Solvent Weld Sewer Pipe (Formerly Canron and Scepter, sister company Canplas )
    - .2 NAPCO BDS Solvent Weld Pipe (Formerly North American Pipe Corporation and Royal Pipe & Fittings)
- .2 Gasketed PVC Sewer Pipe: SDR 35, 100 mm (4") and above, rigid PVC hub and spigot pattern sewer pipe and fittings in accordance with CAN/CSA B182.2, with gasket joints assembled with pipe lubricant from same manufacture as pipe.
  - .1 Acceptable Manufacturers
    - .1 Ipex "Ring-Tite" Sewer Pipe (Formerly Canron and Scepter, sister company Canplas )
    - .2 NAPCO Gasketed Sewer Pipe SDR 35/26 (Formerly North American Pipe Corporation and Royal Pipe & Fittings)
    - .3 Next Polymers "Duraloc" Sewer Pipe
- .3 PVC DWV Pipe: Ipex Inc. System 15 rigid PVC drain, waste, and vent pipe and fittings manufactured to CAN/CSA B181.2, complete with solvent weld joints. Solvent weld cement and primer (when required by manufacture) shall be same manufacturer as pipe. When used in buildings of non-combustible construction all PVC pipes shall be certified to CAN/ULC S102.2 and achieve a Flame Spread Rating not exceeding 25. System 15 shall not be used in high buildings or air plenums. For dry fire barrier penetration, an approved firestop conforming to the requirements of ULC/CAN S115-M95 shall be installed at all fire rated walls.
  - .1 Acceptable Manufacturers
    - .1 Ipex "System 15" DWV Pipe (Formerly Canron and Scepter, sister company Canplas )
    - .2 NAPCO NAPSYS™ - LR PVC DWV 25 Pipe (Formerly North American Pipe Corporation and Royal Pipe & Fittings)
- .4 Plenum Rated PVC DWV Pipe: Ipex Inc. System XFR rigid PVC drain, waste, and vent pipe and fittings to CAN/CSA B181.2, complete with solvent weld joints. Solvent weld cement and primer (when required by manufacture) shall be same manufacturer as pipe. When used in buildings of non-combustible construction, high buildings, and air plenums all PVC pipes shall

be certified to CAN/ULC S102.2, achieve a Flame Spread Rating not exceeding 25 and achieve Smoke Developed Classification not exceeding 50. For dry fire barrier penetration, an approved firestop conforming to the requirements of ULC/CAN S115-M95 shall be installed at all fire rated walls.

.1 Acceptable Manufacturers

- .1 Ipex "XFR" DWV Pipe (Formerly Canron and Scepter, sister company Canplas )
- .2 NAPCO NAPSYS™ - HR PVC DWV 25/50 Pipe (Formerly North American Pipe Corporation and Royal Pipe & Fittings)

- .5 DWV Copper - Solder Joint: Type DWV hard temper in accordance with ASTM B306, complete with wrought copper solder type drainage fittings, ANSI/ASME B16.29 or cast copper solder type drainage fittings, ANSI/ASME B16.23. Soldered joints made using 96-0.5-4 tin silver copper, 95-5 tin antimony, 96-6 tin silver, or 96-4 tin silver solder, conforming to ASTM B32.
- .6 Cast Iron: Cast iron pipe, fittings and joints in accordance with CAN/CSA B70, couplings to CAN/CSA B602 (Class 4000).
- .7 Ductile Iron: Centrifugally cast ductile iron to ANSI/AWWA C151/A21.51 complete with ANSI/AWWA C104/A21.4 cement lining, and ANSI/AWWA C105/A21.5 protective polyethylene film (minimum nominal thickness of 200 microns and minus tolerance with 10 percent). Fittings to be cement lined ductile-iron/cast-iron mechanical joint fittings to ANSI/AWWA C110/A21.10. Rubber gasket joints for cast-iron or ductile-iron water pipes shall conform to ANSI/AWWA C110/A21.11.
- .8 DWV Copper-Grooved Coupling Joint: Type DWV hard temper in accordance with ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic Co. "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings or Grinnell (Tyco Mechanical Products) Style 672.

3 EXECUTION

3.1 UNDERGROUND MUNICIPAL SERVICE CONNECTION

- .1 All underground sanitary and storm sewers outside the building footprint (1.5 m from the outside of the foundation wall to the property line) shall be covered by the Civil Division, refer to Civil Specifications related to storm and sanitary sewer installation included within the Civil Specification Book ACL-GHIB-CAPE-SPEC0006.

3.2 PIPING INSTALLATION REQUIREMENTS

- .1 Provide all required drainage, waste, and vent piping. Pipe, unless otherwise specified in the Contract Documents, shall be as follows:
  - .1 For underground sanitary and storm pipe inside the building footprint use rigid PVC Sewer Pipe, minimum 100 mm (4") diameter.
    - .1 For pipe sizes 150 mm (6") diameter and smaller use Solvent Weld PVC Sewer Pipe, for all larger pipe diameters use Gasketed PVC Sewer Pipe installed in accordance with National Plumbing Code and manufacturer installation requirements and recommendations.
    - .2 Where permitted by the NBC, Ductile Iron or Cast Iron may be used in lieu of PVC DWV Pipe .
  - .2 For sanitary and storm pipe inside the building and above ground in sizes up to and including 65 mm (2½") diameter type DWV Copper shall be used. Where permitted by the NBC, PVC DWV Pipe may be used in lieu of DWV Copper.

- .3 For sanitary and storm pipe inside the building and above ground in sizes 75 mm (3") diameter and larger - Cast Iron shall be used except for drainage pump discharge pipe. Where permitted by the NBC, PVC DWV Pipe may be used in lieu of Cast Iron.
- .4 In high buildings or air plenums Plenum Rated PVC DWV Pipe shall be used in lieu of PVC DWV Pipe.
- .2 Lay pipes true to line and grade with bells upgrade. Fit sections together so that, when complete, the pipe has a smooth and uniform invert. Keep pipe thoroughly clean so that jointed compound will adhere. Inspect the pipe for defects before lowering the pipe into the trench. Do not use defective pipe.
- .3 The following publications shall be used to establish class of bedding and class of piping for installation other than the above. They shall also serve as guide for preparation of bedding, installation and testing.
  - .1 Cast iron soil pipe and fittings handbook of the cast iron soil pipe institute.
  - .2 Sewer Design & Construction of the Water Pollution Control Federation.
  - .3 The Blue Brute and Ring Tite PVC gravity sewer pipe installation Guide by Johns-Manville.
- .4 Unless otherwise specified in the Contract Documents, slope horizontal drainage piping above ground in sizes to and including 75 mm (3") diameter 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") diameter and larger 25 mm (1") in 2.4 m (8').
- .5 Install and slope underground drainage piping to inverts or slopes indicated on the Drawings to facilitate straight and true gradients between the points shown. Verify available slopes before installing the pipes.
- .6 Unless otherwise specified in the Contract Documents, slope horizontal branches of vent piping down to the fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 (4').
- .7 Extend vent stacks up through the roof generally where shown but with exact locations to suit site conditions. Terminate vent stacks 457 mm (18") above the roof in vent stack covers.
- .8 Provide proper dielectric unions at connections between copper pipe and ferrous pipe or equipment.
- .9 Piping and fittings installed throughout the project shall be as uniform as commercially practicable, contractor is responsible to ensure proper joints are made between pipe and fittings of different materials/manufacturers.

### 3.3 PIPE PRESSURE TESTING:

- .1 Refer to Section 20 05 00 – General Mechanical Requirements, for test pressure for drainage and venting systems.

**END OF SECTION 22 13 16**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 ASTM International Inc.
  - .1 ASTM A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
  - .2 ASTM A48, Standard Specification for Gray Iron Castings.
  - .3 ASTM A563, Standard Specification for Ductile Iron Castings.
  - .4 ASTM B584, ASTM Specification for Copper Alloy Sand Castings.
  - .5 ASTM C 1173, Standard specification for flexible transition couplings for underground piping systems
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME B1.20.1, Pipe Threads, General Purpose, Inch
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA B602, Mechanical couplings for drain, waste, and vent and sewer pipe.
  - .2 CAN/CSA B182.2, PSM Type Polyvinylchloride (PVC) Sewer Pipe and Fittings.
  - .3 CSA B272-93, Prefabricated Self-Sealing Roof Vent Flashings
  - .4 CAN/CSA-B602, Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.
- .4 National Building Code (NBC)
- .5 Underwriter's Laboratories (UL)
  - .1 UL 2043, Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings: Submit shop drawings for all products specified in this Section except pipe and fittings. Shop drawings are to include all components including but not limited to panel layout drawings, wiring diagrams with wire numbers, individual components within panel, motor shop drawing, etc.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 SHUT-OFF VALVES AND CHECK VALVES

- .1 Shut-off Valves: Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass or bronze body, blowout-proof stem, chrome plated brass ball,

solder or screwed ends as required, and removable lever handle. Where piping is insulated provide stem extensions to clear insulation. Acceptable products are:

- .1 Kitz Corporation Code 58 or Code 59
  - .2 Toyo Valve Co. Fig. 5049A or Fig. 5044A
  - .3 M.A. Steward & Sons Ltd. MAS B-3 or MAS B-4
  - .4 Nibco inc. #SFP-600 or TFP-600 (Brass)
  - .5 Nibco Inc. #S-585-70 or T-585-70 (Bronze)
  - .6 Victaulic Co. of Canada Ltd. Series 722
  - .7 Anvil International Inc. Fig. 171N
  - .8 Watts Water Technologies (Canada) Inc. #FBV-3 or FBVS-3
- .2 Ball Check Valves: ASTM A48 Class 30, epoxy coated cast iron, minimum 1725 kPa (100 psi) WOG rated ball check valve with screwed ends, for horizontal and vertical piping. Check valve to be designed specifically for storm and wastewater applications. Self-cleaning, natural rubber or nitrile (Buna-N) ball, weighted depending on application. Acceptable products are:
- .1 Flowmatic Model 208 or 508
  - .2 AVK Group PN 10 Variant 53/30-005
  - .3 Crane Company, Barnes Ball Check Valve

## 2.2 VENT STACK COVERS

- .1 Thaler Metal Industries Ltd. Model SJ-27 (or approved equivalent), 304 stainless steel, 0.79 mm (22 ga), insulated, 457 mm (18") high vent stack covers with factory applied asphalt primer coating on the top and bottom of the flange or approved equivalent. To CSA B272-93; with removable cap, pre-molded urethane insulation liner, and EPDM Base Seal.

## 2.3 CLEANOUTS

- .1 Horizontal Piping:
  - .1 Indoor: TY pipe fitting with an extra heavy brass plug screwed into the fitting.
  - .2 Outdoor: Extra Heavy Duty cleanout for outdoor application designed to handle safe live of 4500 kg in accordance with ASME A112.21.1M, stainless steel top, body and plug, vandal proof top. Watts Water Technologies (Canada) Inc. #CO-1200-RX-6-28 or equivalent from Zurn, Jay R. Smith, and Mifab.
- .2 Vertical Piping:
  - .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, epoxy coated cast iron cleanout tees, each gas and water-tight, complete with an ABS tapered thread plug. Acceptable cast iron cleanout tees are:
    - .1 Zurn #Z-1445
    - .2 Jay R. Smith #4510
    - .3 Mifab #C1460
    - .4 Watts Water Technologies (Canada) Inc. #CO-460
  - .2 Heavy Duty Cleanout with polished stainless steel top.
    - .1 Zurn #ZS-1400-BZ1

- .2 Acceptable alternates from Jay R. Smith, Mifab or Watts Water Technologies (Canada) Inc.
  - .3 Urinal(s): Wall access cleanout assemblies, each complete with a tapered plug, threaded brass insert, urethane rubber seal, and polished stainless steel access cover with vandalproof stainless steel securing screw. Acceptable products are:
    - .1 Zurn #Z-1666-1-VP
    - .2 Jay R. Smith #SQ4-1819
    - .3 Mifab #C1440-RD-6
    - .4 Watts Water Technologies (Canada) Inc. #CO-440-RD-6
- 2.4 **FLOOR CLEANOUT TERMINATIONS**
  - .1 Baked epoxy coated cast iron terminations, each complete with a solid stainless steel gasketed access cover to suit the floor finish, a cleanout plug, and captive stainless steel securing hardware. Acceptable products are:
    - .1 Zurn #ZS-1602-SP Series
    - .2 Jay R. Smith #4020-SS-F-C Series
    - .3 Mifab #C1000-R-3-34
    - .4 Watts Water Technologies (Canada) Inc. #CO-1200-R-3-34
  - .2 All cleanout terminations in areas with a tile or sheet vinyl finish are to be as above but with a square top in lieu of a round top. Refer to the Room Finish Schedule.
- 2.5 **BACKWATER VALVES**
  - .1 Heat bonded powder epoxy coated cast iron in-line type, each complete with a bolted and gasketed cover, bronze flapper, extension, and stainless steel hardware. Acceptable products are:
    - .1 Zurn Industries LLC #Z-1095-15J
    - .2 Jay R. Smith MFG Co. #7022
    - .3 Mifab Inc. #BV1200R
    - .4 Watts Water Technologies (Canada) Inc. #BV-230-R
- 2.6 **BACKWATER VALVES WITH ACCESS CHAMBER AND COVERS**
  - .1 Heat bonded powder epoxy coated cast iron in-line type, each complete with a bolted and gasketed cover, bronze flapper, and stainless steel hardware, coated steel access chamber with anchor flange, heavy duty checker plate steel secured access cover. Acceptable products are:
    - .1 Zurn Industries LLC #Z-1095-HOCAH-K
    - .2 Jay R. Smith #SQ-7-3311/7012
    - .3 Mifab Inc. #BV-1000 c/w BV-1280
    - .4 Watts Water Technologies (Canada) Inc. #BV-240
- 2.7 **BACKWATER VALVES – FLAPPER TYPE**
  - .1 Heat bonded powder epoxy coated cast iron body with hub inlet and open outlet for installation at end of drainage line, bronze flapper, type, each complete with a bolted and gasketed cover, bronze flapper, stainless steel hardware. Acceptable products are:
    - .1 Zurn Industries Inc. #Z-1091-BV



- .2 Jay R. Smith MFG Co. #7070C
- .3 Mifab Inc. #BV1280
- .4 Watts Water Technologies (Canada) Inc. # BV-200-½

**2.8 BOTTOM OUTLET FLOOR DRAIN BACKWATER VALVES – BALL TYPE**

- .1 Heat bonded powder epoxy coated cast iron body, complete with plastic ball float, removable bronze backwater bushing (ring), and replaceable neoprene seat. Designed to be installed directly under various floor drain bodies to prevent damaging backflow from entering room and sized to match floor drain outlet. Acceptable products are.
  - .1 Zurn Industries Inc. #Z-1099
  - .2 Jay R. Smith MFG Co. #7080
  - .3 Mifab Inc. #BV1260
  - .4 Watts Water Technologies (Canada) Inc. # BV-300

**2.9 PIPING SIESMIC / EXPANSION COMPENSATORS (ABOVE GRADE)**

- .1 Piping at seismic expansion joints shall be protected against damage via the insertion of braided flexible hose assemblies, bellows expansion joints, or PVC flexible expansion joints. Bellows expansion joints to be used in locations with spacing limitations.
- .2 Seismic/Expansion compensators shall be rated for the same axial/lateral motion as the building expansion joints (as noted in the Architectural/Structural drawings), or where not noted for a minimum of ±2" (50mm) of lateral motion in all planes and ±2" (50mm) of axial motion. Seismic/Expansion compensators located outdoors shall be rated for temperatures between -20C to 40C (-4F to 104F), and UV resistant (if exposed to sunlight).
- .3 All submittals shall include a recognized test report, covering the full range of the specified movements at the operating pressures.
- .4 Seismic/Expansion compensators in drainage lines shall be rated for a minimum operating pressure of 103 kPa (15 psi) and be constructed of PVC or 300 series stainless steel with solvent weld, grooved ends, and/or to suit application. Guiding and anchoring (based off expected forces) shall be as designed by the manufacturer and included with the submittals.
- .5 Acceptable manufactures are:
  - .1 Metraflex Company.
  - .2 Senior Flexonics
  - .3 Manson Industries Inc.
  - .4 Hyspan Precision Products.
  - .5 Flexicraft Industries.
  - .6 EBAA Iron Inc, DWV FLEX-TEND.

**2.10 PIPING SIESMIC / EXPANSION COMPENSATORS (BELOW GRADE)**

- .1 Flexible expansion joints shall be manufactured of ductile iron conforming to the material requirements of ASTM A536 and/or ANSI/AWWA C153/A21.53 and suitable for installation on ductile iron, carbon steel, or PVC pipes. All fasteners shall be Type 304 Stainless Steel. Product shall be suitable for direct burial and for use with wastewater systems (storm/sanitary) per local code requirements.
- .2 Each flexible expansion joint shall be pressure tested prior to shipment against its own restraint to a minimum of 2410 kPa (350 psi) on pipe sizes 75 mm (3 in.) to 600 mm (24 in)

and 1720 kPa (250 psi) on pipe sizes 750 mm (30 in.) and larger. A minimum 2:1 safety factor, determined from the published pressure rating, shall apply.

- .3 Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having 4-inches minimum expansion and a minimum per ball deflection of:
  - .1 20 degrees for pipe sizes 75 mm (3 in.) to 250mm (10in.)
  - .2 15 degrees for pipe sizes 300 mm (12 in.) to 750mm (30 in.)
  - .3 12 degrees for pipe sizes 900 mm (36 in.) to 1200 mm (48 in)
- .4 Additional expansion sleeves shall be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections shall be available.
- .5 All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating shall meet ANSI/NSF-61.
- .6 Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16.
- .7 Appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be provided for direct buried applications.
- .8 Manufacturer's certification of compliance to the above standards and requirements shall be readily available upon request. Acceptable manufactures are:
- .9 FLEX-TEND c/w flanged joint, Series 2000PV MEGALUG, or Series 1100 MEGALUG (as required), by EBAA Iron Inc.
- .10 StarFlex Series 5000, by Star Pipe Products.

#### 2.11 **TRANSITION COUPLING**

- .1 Adaptors, connector, or mechanical joints used to join dissimilar material shall be designed to accommodate the required transition.
- .2 All mechanical couplings shall conform to CSA B602.
- .3 Couplings used in direct burial applications shall be designed for resistance against heavy earth and shear forces and conform to ASTM C 1173 in addition to CSA B602, all banding and shielding shall be constructed of 316 stainless steel.

#### 2.12 **CONDENSATE PUMPS**

- .1 Condensate pumps shall be plenum rated; constructed with materials that have been tested and meet UL 2043.
- .2 Pumps to be complete with built-in check valve and capable of a flow rate of 144 L/hr (38 USgal/hr) at 3.66 m (12 ft.) of head; with a maximum lift of 5.5m (18 ft.)
- .3 Pump shall be controlled by a float switch mechanism, which automatically starts and stops the pump. Pumps shall also be complete with a high-water level switch, and wired to either stop the production of condensate or operate an external alarm or relay.
- .4 Each pump shall be CSA or cUL certified and complete with their own hardwired 115 V, 280 V, or 230 V electrical connection to match the voltage of FCU.
- .5 Acceptable Manufacturers:
  - .1 Hartell (Ingersoll Rand)
  - .2 Little Giant (Franklin Electric Co.)

### 3 EXECUTION

#### 3.1 INSTALLATION OF SHUT-OFF AND CHECK VALVES

- .1 Provide shut off valves on pump discharge and wherever else indicated on the drawings.
- .2 Provide check valves on pump discharge and wherever else indicated on the drawings.

#### 3.2 SUPPLY OF VENT STACK COVERS

- .1 Supply a properly sized vent stack cover for each vent stack penetrating the roof.
- .2 Hand the vent stack covers to the roofing Contractor at the site for installation and flashing into roof construction as part of the roofing work. Coordinate the installation with the roofing Subcontractor to ensure proper locations. Provide waterproofing caps over vent stacks.

#### 3.3 INSTALLATION OF CLEANOUTS

- .1 Provide cleanouts in drainage piping in locations as follows:
  - .1 In the building drain or drains as close as possible to the inner face of the outside wall, and, if a building trap is installed, locate the cleanout on the downstream side of the building trap.
  - .2 At or as close as practicable to the foot of each drainage stack.
  - .3 At maximum 15 m (50 foot) intervals in horizontal pipe 100 mm (4 inch) diameter and smaller.
  - .4 At maximum 30 m (100 foot) intervals in horizontal pipe larger than 100 mm (4 inch) diameter.
  - .5 In the wall at each new urinal or bank of urinals in a washroom.
  - .6 Wherever else shown on the Drawings.
- .2 Cleanouts are to be the same diameter as the pipe in piping to 100 mm (4 inch) diameter, and not less than 100 mm (4 inch) diameter in piping larger than 100 mm (4 inch) diameter.
- .3 Cleanouts in vertical piping are to be cleanout tees, cast iron in piping 75 mm (3 inch) diameter and larger, copper or bronze in piping smaller than 75 mm (3 inch) dia.
  - .1 In locations with Heavy Duty vertical loads (>2500 lbs), heavy duty cleanouts shall be used.
- .4 Cleanouts in horizontal piping are to be TY fittings with removable plugs.
- .5 Where cleanouts are concealed behind walls or partitions, install the cleanouts near the floor and so that the cover is within 25 mm (1 inch) of the finished face of the wall or partition.

#### 3.4 INSTALLATION OF FLOOR CLEANOUT TERMINATIONS

- .1 Where cleanouts occur in horizontal inaccessible underground piping, extend the cleanout TY fitting up to the floor and provide a cleanout termination set flush with the finished floor.
- .2 In waterproof floors, ensure that each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit the floor finish. Refer to Room Finish Schedules.
- .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.

#### 3.5 INSTALLATION OF BACKWATER VALVES

- .1 Provide backwater valve(s) in drainage piping where shown on the Drawings and connect with piping as indicated on the Drawings.

- .2 Set the backwater valve assembly such that the cover is flush with the finished floor. Provide an extension piece if required due to the depth of the piping.

### 3.6 **INSTALLATION OF SIESMIC / EXPANSION COMPENSATORS**

- .1 Provide expansion compensators in drainage piping at building expansion joints and where shown on Drawings.
- .2 Ensure that pipe ends are properly aligned. Provide alignment guides as required, and anchor piping where indicated by means of anchors supplied by the expansion compensator manufacturer or by means of approved site fabricated anchors.
- .3 When installed in a gravity drainage system the expansion joint shall be installed in such a manner that if downward deflection were to occur on the pipe upstream (inlet) of expansion joint shall, the pipe downstream (outlet) of the expansion joint shall still be maintained at a lower elevation.

### 3.7 **INSTALLATION OF CONDENSATE PUMPS**

- .1 Provide condensate pumps for all air conditioning, refrigeration, and dehumidification equipment where gravity drainage is not possible or practical; or wherever else indicated on drawings.
- .2 Condensate pumps shall be low-profile where required to fit into ceiling areas with limited space; or as indicated on drawings.
- .3 Install as per manufacturers written instructions, coordinate final electrical connections with all trades.

**END OF SECTION 22 13 19**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 ASTM International Inc.
  - .1 ASTM A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
  - .2 ASTM A48, Standard Specification for Gray Iron Castings.
  - .3 ASTM A563, Standard Specification for Ductile Iron Castings.
  - .4 ASTM B584, ASTM Specification for Copper Alloy Sand Castings.
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME B1.20.1, Pipe Threads, General Purpose, Inch
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA B70, Cast iron soil pipe, fittings, and means of joining.
  - .2 CAN/CSA B602, Mechanical couplings for drain, waste, and vent and sewer pipe.
  - .3 CAN/CSA B182.2, PSM Type Polyvinylchloride (PVC) Sewer Pipe and Fittings.
- .4 Deutsches Institut für Normung (DIN)
  - .1 DIN19580 / EN 1433, Drainage Channels For Vehicular And Pedestrian Areas

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings: Submit shop drawings for all products specified in this Section except pipe and fittings. Shop drawings are to include all components including but not limited to panel layout drawings, wiring diagrams with wire numbers, individual components within panel, motor shop drawing, etc.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 - Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 FLOOR DRAINS (FD & FFD)

- .1 Epoxy coated cast iron body, each complete with a 12 mm (1/2") diameter trap primer connection, and each in accordance with the Floor Drain Schedule below.
- .2 All floor drains in areas with a tile or sheet vinyl finish are to be as above but with a square grate in lieu of a round grate. Refer to the Room Finish Schedule.
- .3 Strainers shall be adjustable nickel bronze, 6.35 mm (1/4") thick, and secured with vandal-proof stainless steel (S.S.) screws. In locations with heavy duty vertical loads (>2500 lbs) a S.S. strainer shall be used in lieu of nickel bronze.
- .4 Funnel floor drains shall come complete with a polished nickel bronze funnel assembly with vandal-proof S.S. screws, each in accordance with the Floor Drain Schedule below.

### 3 EXECUTION

#### 3.1 INSTALLATION OF FLOOR DRAINS

- .1 Provide and install drains where shown on the Drawings. Equip each drain with a trap and trap primer line.
- .2 Confirm the exact location of drains based on architectural drawings prior to roughing in, coordinate installation with formwork installation.
- .3 In equipment rooms and similar areas, exactly locate floor drains to suit the location of mechanical equipment and equipment indirect drainage piping.
- .4 Temporarily plug floor drains during construction procedures. Remove plugs during final cleanup work and demonstrate free and clear operation of each drain. Replace any damaged grates.

### 4 FLOOR DRAIN SCHEDULE

Type and Description	Zurn Model No.	J.R. Smith Model No.	Mifab Model No.	Watts Model No.
<b>FD - Floor drain, finished areas:</b> Floor drains shall be round 127 mm (5") dia strainer, 100 mm (4") throat on strainer. Nickel bronze or S.S. as per 2.1(C).	ZN-415-B5-P-VP	2005-A05-NB-U-P050	F1100-C-5-1-7-6	FD-100-A5-1-6
<b>FD - Floor drain, finished areas, no membrane:</b> Floor drains shall be round 127 mm (5") dia strainer, 100 mm (4") throat on strainer. Nickel bronze or S.S. as per 2.1(C).	ZN-211-A5-P-VP	1753-A05-NB-U-P050	F1100-5-1-7-6	FD-200-A5-1-6
<b>FD – Floor drain, tiled areas:</b> Floor drains in quarry or mosaic tiled areas shall be similar to other floor drains but c/w 127 mm x 127 mm (5" x 5") square nickel bronze strainer. Nickel bronze or S.S. as per 2.1(C).	ZN-415-Y5-P-VP	2005-B05-NB-U-P050	F1100-C-S5-1-7-6	FD-100 -L5-1-6
<b>FD – Floor drain, tiled areas, no membrane:</b> Floor drains in quarry or mosaic tiled areas shall be similar to other floor drains but c/w 127 mm x 127 mm (5" x 5") square nickel bronze strainer. Nickel bronze or S.S. as per 2.1(C).	ZN-211-Y5-P-VP	1753-B05-NB-U-P050	F1100-S5-1-7-6	FD-200-L5-1-6
<b>FFD - Funnel floor drain:</b> Funnel floor drains shall be similar to floor drains but c/w nominal 75 mm x 225 mm (3" x 9") oval funnel.	ZN-415-BF	2005-A05-3591	F1100C-EG-1	FD-100-C-EG-1
<b>FFD - Funnel floor drain, no membrane:</b> Funnel floor drains shall be similar to floor drains but c/w nominal 75 mm x 225 mm (3" x 9") oval funnel.	ZN-211-BF	1753-A05-3591	F1100-EF-1	FD-200-EG-1

END OF SECTION 22 13 20

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 ASTM International Inc.
  - .1 ASTM A48, Standard Specification for Gray Iron Castings.
  - .2 ASTM A536, Standard Specification for Ductile Iron Castings
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME B1.20.1, Pipe Threads, General Purpose, Inch
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA B70, Cast iron soil pipe, fittings, and means of joining.
  - .2 CAN/CSA B602, Mechanical couplings for drain, waste, and vent and sewer pipe.

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings: Submit shop drawings for all products specified in this section. Provide the manufacturer's printed product literature and datasheets including product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 ROOF DRAINS (RD)

- .1 Baked epoxy coated cast iron body, complete with aluminum dome, adjustable extension, deck clamp, sump receiver drains. Each in accordance with "Roof Drain Schedule" below.

3 EXECUTION

3.1 INSTALLATION OF ROOF

- .1 Supply roof drains and place roof drain bodies in position for flashing into roof construction as part of the roofing work. Connect with piping and provide accessories.
- .2 Protect roof drains from damage and entrance of debris until roofing work is complete.
- .3 Ensure roof drains are installed at low points of roof and co-ordinate locations with requirements of all disciplines.

4 ROOF DRAIN SCHEDULE



Type and Description	Zurn Model No.	J.R. Smith Model No.	Mifab Model No.	Watts Model No.
<b>RD</b> , 300mm (12 in) diameter body, for conventional roof.	ZA-121-DP- E-R	1010-E-R-C- AD	R1200 -B-E- U-M	RD-100-BDF- K80

END OF SECTION 22 14 26

## 1 GENERAL

### 1.1 SUMMARY

.1 This Section includes requirements for supply and installation of the following:

.1 Instantaneous Electric Hot Water Heaters

### 1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings

.2 Canadian Standards Association (CSA International)

.1 CSA C22.2 No. 110, Electric Storage-Tank Water Heaters.

.2 CSA-C22.2 No. 64, Household cooking and liquid-heating appliances.

.3 CSA-C22.2 No. 88, Industrial heating equipment.

.4 CAN/CSA-C191-04, Performance of Electric Storage Tank Water Heaters for Domestic Hot Water Service.

### 1.3 SUBMITTALS

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

.2 Product Data:

.1 Provide the Manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings for all equipment listed in this Section.

### 1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.

.2 Deliver materials to site in its original factory packaging, labelled with the Manufacturer's name and address.

.3 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 ELECTRIC – WALL MOUNT – TANKLESS TYPE WATER HEATER

.1 Construction:

.1 The heater(s) shall be fully covered by a plastic and/or powder coated galvanized steel enclosure and complete with wall mounted bracket.

.2 All components shall be NSF61 and/or NSF 372 listed.

.3 Maximum operating pressure of 150 PSI.

.2 **Element:** Stainless steel heating chambers and sheathed copper heating elements, cartridge style, designed for field replacement. Water heater flow shall modulate power to the heating elements to maintain a user-selected output temperature.

- .3 **Water Connections:** Bottom mounted water connections, fittings to suit comment plumbing sizes (NTP). Replaceable filter shall be provided on inlet connection
- .4 Units shall be cUL or ETL listed under CSA-C22.2 No. 64/No. 88.
- .5 Controls:
  - .1 Units shall have a turn-on water flow as indicated in the schedules.
  - .2 Tankless water heater to utilize algorithm, to actively managing power application to real time system demand. Integrated flow meter, along with inlet and outlet temperature sensors provide data shall allow the unit to instantly adapt to variations in input parameters.
  - .3 Selectable display including Celsius /Fahrenheit, setpoint, flowrate, inlet temperature outlet temperature, power factor.
  - .4 Diagnostic features to include error/fault display and maintain error/fault history of 5 events.
- .6 Refer to schedule on drawing(s).
- .7 Acceptable alternates subject to shop drawing review:
  - .1 Eemax
  - .2 AO Smith
  - .3 Rheem

### 3 Execution

#### 3.1 INSTALLATION

- .1 Set water heater(s) in place where shown and install in strict accordance with manufacturer's written instructions.
- .2 Provide pressure relief valve for each water heater(s) as required by local building code. Extend pressure relief valve outlet piping at full line size, complete to drain. Drains and overflows shall be piped to the closet drain outlet. Install flue as instructed.
- .3 All interconnecting piping and valves shall be provided as indicated in schematic arrangement as detailed on drawings.

### 4 EXECUTION

#### 4.1 INSTALLATION

- .1 All electrical equipment shall be installed to and meet the requirements of CSA C22.2 and be labelled accordingly.
- .2 Install wall/platform mount water heaters on brackets and/or platform. Furnish all anchors, hangers, secondary structure, and fasteners required to install the heater as shown on the drawings.
- .3 Follow manufacturer's installation guidelines.
- .4 At time of start-up the manufacturer shall check the efficiency, instruct the Project Co. and provide a written report to the Consultant detailing all work undertaken.

**END OF SECTION 22 34 37**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 ANSI
  - .1 ANSI Z358.1-2014 Emergency Eyewash and Shower Standard
- .2 ASTM
  - .1 ASTM C-564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .3 ASTM C1460 - 12 Standard Specification for Shielded Transition Couplings for Use With Dissimilar DWV Pipe and Fittings Above Ground. Canadian Standards Association (CSA International).
  - .1 CAN/CSA-B45 Series, Plumbing Fixtures.
  - .2 CAN/CSA-B125.3, Plumbing Fittings.
  - .3 CSA Standard B602-2010, Mechanical couplings for drain, waste, and vent pipe and sewer pipe
  - .4 CAN/CSA-B651, Accessible Design for the Built Environment.
- .4 International Association of Plumbing and Mechanical Officials (IAPMO)
- .5 National Plumbing Code of Canada
- .6 National Building Code 2015 (NBC)
- .7 Uniform Plumbing Code

1.2 ACTIONS AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
- .3 Provide manufacturer's printed product literature and datasheets for fixtures and include product characteristics, performance criteria, physical size, finish and limitations.
- .4 Closeout Submittals:
- .5 Provide maintenance data in accordance with Section 01 70 00 – Execution and Closeout Requirements.
- .6 Include:
  - .1 Description of fixture and trim, giving manufacturer's name, type, model, year, capacity.
  - .2 Details of operation, servicing, maintenance.
  - .3 List of recommended spare parts.
- .7 Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
- .2 Separate waste materials for reuse and recycling.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material, in appropriate on-site bins.
- .4 Fold up metal and plastic banding, flatten and place in designated area for recycling.

## 2 PRODUCTS

### 2.1 PLUMBING FIXTURE AND FITTING SCHEDULE

- .1 For plumbing fixture and fitting manufacturers, catalogue numbers, and specific requirements, refer to the Drawing schedule of plumbing fixtures and fittings.
- .2 Unless otherwise specified in the Contract Documents, requirements specified below apply to the plumbing fixtures and fittings scheduled on the Drawings.

### 2.2 GENERAL: PLUMBING FIXTURES AND FITTINGS

- .1 Fixtures and fittings, where applicable, shall be in accordance with the requirements of CSA B45 Series, Plumbing Fixtures.
- .2 All fixtures and fittings for use by the handicapped are to be in accordance with NBC requirements.
- .3 Unless otherwise specified in the Contract Documents, all vitreous china and porcelain enamelled fixtures shall be white.
- .4 Unless otherwise specified in the Contract Documents, all fittings exposed to view shall be chrome plated and polished.
- .5 All fittings located in areas other than private washrooms shall be vandal-proof.
- .6 All fixtures carriers shall be suitable in all respects for the fixture they support and the construction in which they are located.

### 2.3 WC-1: TOILET - FLOOR MOUNTED WITH FLOOR OUTLET

- .1 **Niagara Stealth Phantom Toilet** - Tank type Toilet, Floor mounted with floor outlet, High Efficiency HET 3 LPF (0.8 GPF), Vitreous china, White finish, EverClean® antimicrobial surface, Elongated bowl, Right Height® rim at 432 mm (17"), Minimum 305 mm (12") rough-in from wall to the center of waste outlet, Siphon jet flush action, Manual, Polished chrome left-hand trip lever, Tank not lined, Without tank cover locking device, Gravity-assisted flush, flushing system, 76 mm (3") flush valve, metal shank fill valve, Tank coupling components, 203 x 152 mm (8" x 6") water surface area, Fully-glazed 54 mm (2-1/8") trapway, one flush thoroughly evacuates the bowl every time eliminating double flushing, 406 mm (16") wide, 711 mm (28") from finished wall, 800 mm (31-1/2") high, ASME A112.19.2 compliant, CSA B45.1 compliant, EPA WaterSense® compliant.
- .2 **Centoco 820STSFE-001 Seat** - FAST-N-LOCK, For elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, With seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish, FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel, 25 mm (1") high, 470 mm (18-1/2") long, 362 mm (14-1/4") wide.
- .3 **McGuire LFBV172 Supply** - CONVERTIBLE™ Commercial Toilet Supply kit, consisting of (1) stop valve, (1) riser, (1) flange, Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, 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. toilet flexible copper riser tube (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 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.

### 2.4 LAV-1: WALL HUNG BASIN - BARRIER FREE - ELECTRONIC FAUCET

- .1 **American Standard 0955901EC.020 Basin** - MURRO, Wall-hung Lavatory, Vitreous china, EverClean® antimicrobial surface, White finish, Single hole centerset, Less overflow, Faucet ledge with recessed self-draining deck, For concealed arm or wall support, Soap dispenser,

When installed with a below deck electronics faucet which has the control box, the accessories will not fit under the shroud and will need to be installed outside the shroud, Overall Dimensions: 545 mm (21-7/16") long, 540 mm (21-1/4") wide, 152 mm (6") high, Bowl Dimensions: 343 mm (13-1/2") long, 394mm (15-1/2") wide, 127 mm (5") deep.

- .2 **American Standard 7075100.002 Faucet** - COLONY®, Counter mounted, Manual, Single handle, Lavatory faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant Metal body, 610 mm (24") colour-coded braided flexible supply hoses with 10 mm (3/8") compression connections, Ceramic disc cartridge, 4.5 LPM (1.2 GPM) maximum flowrate, Pressure compensating aerator, Fixed Mid-arc spout, 111 mm (4-3/8") spout reach, 157 mm (6-3/16") high, Lever handle, Metal pop-up drain.
- .3 **McGuire PRODRAIN Fixture Drain** - Patented grid drain, Straight drain, Lavatories without overflows, Heavy cast brass, Chrome-plated finish, Without overflow holes, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long tailpiece, Brass locknut, Heavy rubber basin washer Fiber friction washer, CSA compliant
- .4 **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.
- .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.

## 2.5 **KS-1: COUNTER MOUNTED, UNDERMOUNT, KITCHEN SINK**

- .1 **Franke Commercial LBS4010P-1-1 Sink** - Single compartment sink, Single hole centerset, Commercial sinks, with overall dimension 562 mm (22-1/8") long, 478 mm (18-13/16") wide, 254 mm (10") high, constructed from 18 gauge Type 304 Stainless steel, Bowl dimensions are 508 mm (20") long, 356 mm (14") wide, 254 mm (10") deep, Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance, Compliances and certifications: ASME A112.19.3 compliant, CSA B45.4 compliant.
- .2 **Chicago Faucets 434-FC1ABCP Faucet** - Counter mounted, Manual, Single handle, Sink faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 compliant ECAST® brass construction, With supply, Ceramic cartridge with volume control, 3.8 LPM (1.0 GPM) maximum flowrate, Spray outlet, Swivel Gooseneck spout, Pull down, 210 mm (8-1/4") spout reach, 432 mm (17") high, Lever handle, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser, Includes hot limit safety stop.
- .3 **Lawler 570-86820 Mixing Valve** - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.
- .4 **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.

- .5 **McGuire 8912CB P-Trap** - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

## 2.6 JS-1: FLOOR MOUNTED, MOP SERVICE SINKS

- .1 **Stern Williams SB-900 Sink** - Single compartment sink, Mop service sinks, with overall dimension 610 mm (24") long, 610 mm (24") wide, 305 mm (12") high, constructed from Precast terrazzo, Bowl dimensions are 546 mm (21-1/2") long, 546 mm (21-1/2") wide, 254 mm (10") deep, Pearl grey marble chips and white portland cement, 76 mm (3") pipe size, cast integrally and provides for a caulked lead connection not less than 25 mm (1") deep to a 76 mm (3") pipe, flat stainless steel strainer, Without tiling flange, With stainless steel cap.
- .2 **Stern Williams T-10-VB 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, Oval or round wall escutcheons, Brass construction, Adjustable supply arms, 1/4 turn ceramic cartridge, 9.5 LPM (2.5 GPM) maximum flowrate, Threaded hose end, Fixed Spout with pail hook, minimum 146 mm (5-3/4") spout reach, maximum 325 mm (11") high, Top brace, 60 mm (2-3/8") lever handle with indexed buttons, Atmospheric vacuum breaker is not intended for continuous pressure applications.
- .3 **Lawler 570-86820 Mixing Valve** - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

## 2.7 EW-1: EYE WASH – FLOOR MOUNTED

- .1 **Guardian G1899-DC Emergency Equipment** - Deck mounted, Ideal for use in highly corrosive environments, cleanrooms and pharmaceutical applications, Type 316 stainless steel, No bowl, GS-Plus, Two spray heads with a flip-top dust cover, internal flow control and filter on each spray head, AutoFlow 90° Swing-Down, 17 1/4" (437mm) high, 1/2" I.P.S. stainless steel plug-type valve with PTFE coated O-ring seals, 1/2" NPT female inlet supply, GS Dust Cover. Addn. for Each Stn. Steel Dust Cover for GS-Plus™ Spray Head in Place of Plastic, Codes and Compliances, ANSI-compliant, Notes, completely assembled units and water tested.
- .2 **Lawler 911E/F-Unit 84908 Mixing Valve** - Emergency mixing valve, Thermostatic High-low master water mixing valve, Rough bronze finish, 229 x 205 x 127 mm (9" x 8" x 5") , 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.

## 2.8 ACCEPTABLE MANUFACTURERS

- .1 Vitreous china and enameled cast iron or steel fixtures: Zurn, Sloan, American Standard, Toto, and Kohler.
- .2 Stainless steel sinks: Franke, AERO, Novanni Stainless Inc., Kindred Industries "Aristaline".
- .3 Precast terrazzo fixtures: Acorn, Fiat Products Ltd. and Stern-Williams.
- .4 Water closet seats: Zurn, Bemis, Centoco, Olsonite and Beneke
- .5 Fixture carriers: Zurn, Mifab, Jay R. Smith and Watts Industries
- .6 Faucets: unless otherwise specified, Zurn, Delta Commercial, American Standard, Kohler and Chicago Faucet
- .7 Fixture trim: unless otherwise specified, McGuire, Zurn, American Standard, Kohler
- .8 Water mixing valves and associated trim: Powers, Zurn, Crane, Symmons, American Standard, Bradley and Kohler
- .9 Floor drains: Watts Industries, Zurn, Mifab, Jay R. Smith
- .10 Emergency Fixtures: Haws, Bradley, Guardian

## 3 EXECUTION

### 3.1 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS

- .1 Provide all required plumbing fixtures and fittings.
- .2 Provide isolation valves (ball valves) for all fixtures.
- .3 Connect plumbing fixtures and fittings with piping sized in accordance with the Drawing schedule.
- .4 Confirm the exact location of all plumbing fixtures and trim prior to roughing-in.
  - .1 Lavatory/Sink Rough-ins: The contractor shall provide evenly spaced water lines at a uniform height above the drain fitting (or otherwise indicated by the manufacturer installation instructions). Contractor shall use either conventional pipe hangers/supports as specified in Section 20 05 29 - Hanger and Supports or non-combustible, dielectrically isolated pipe guides (equivalent to IPEX System XFR Water Line Guide) as practicable/applicable.
  - .2 Rough-ins For Other Fixtures: Contractor shall use conventional pipe hangers/supports as specified in Section 20 05 29 - Hanger and Supports. Refer to manufacturer installation instructions.
- .5 When installation is complete, check and test the operation of each fixture and fitting. Adjust or repair as required.
- .6 Counter Mounted Fixtures and Trim: Supply templates for all counter mounted fixtures and trim and hand to the trade who will but the counter. Ensure openings in the counter are properly located.
- .7 Electronic Lavatory Faucets: Locate control panels for electronic faucets under the lavatories and recessed into the wall. It is the intent to locate the transformer(s) (power converter(s)) in the wall cavity or concealed under counters. Provide access doors accordingly for servicing of transformer(s). Coordinate locations with the work of Division 26 that will provide 120 vac line supply to the transformers(s). Provide low voltage wiring from the transformer(s) to each terminal point in control panel(s) under lavatories. All water and electronic supply from control panel to faucet shall be through the flexible conduit supplied with the control panel. Connect hot and cold-water piping to the mixing valve in each box, and tempered water piping from each mixing valve to the faucet. Set mixing valve maximum temperature limit stops to 43°C.



- (109°F) after potable water systems (hot and cold) are complete. Ensure that each programmable controller is properly programmed, and that water off after deactivation is set for three seconds. Note: All electrical line supply and low voltage wiring, including any wall receptacles as well as low voltage wiring to boxes shall be concealed.
- .8 Thermostatic Mixing Valves: The device shall be designed to be installed at a single outlet. It may be used to supply individual outlets when there is sufficient supply pressure. Ball valves shall be installed on the hot and cold inlet supplies. Temperature shall be field set. Maximum pressure differential shall be 103 kPa (15 psi) between hot and cold inlets. Integral check valves and strainer screen shall be installed on hot and cold supply.
- .9 Shower Fittings: Confirm exact mixing valve and shower head locations with the Consultant prior to roughing-in.

### 3.2 ADJUSTING

- .1 Adjust the water flow rate to design flow rates.
- .2 Adjust the pressure to fixtures to ensure no splashing at maximum pressures.
- .3 Checks:
- .1 Aerators: Verify operation, cleanliness.
  - .2 Vacuum breakers, backflow preventers: Verify operation under all conditions.
  - .3 Thermostatic controls:
  - .4 Verify temperature settings, operation of control, limit and safety controls.

### 3.3 CLEANING AND PROTECTION

- .1 After completing the installation of fixtures, inspect and repair damaged finishes.
- .2 Clean fixtures, faucets, valves and other fittings with the manufacturers' recommended cleaning methods and materials.
- .3 Provide protective covering for installed fixtures and fittings.
- .4 Do not allow the use of fixtures for temporary facilities unless approved in writing by the Project Co. and Owner.

**END OF SECTION 22 42 00**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
  - .1 ANSI B16.9, Factory-Made Wrought Buttwelding Fittings.
  - .2 ANSI B36.19, American National Standard for Welded and Seamless wrought Steel Pipe.
  - .3 ANSI B109.2, Diaphragm Type Gas Displacement Meters.
  - .4 ANSI Z21.24/CSA6.10 Connectors for Gas Appliances.
  - .5 ANSI Z21.69/CSA 6.16 Connectors for Moveable Gas Appliances.
  - .6 ANSIZ21.75/CSA 6.27 Connectors for Outdoor Gas Appliances and Manufactured Homes
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME B1.20.1, Pipe Threads, General Purpose.
  - .2 ASME B31.9, Building Services Piping.
- .3 ASTM International Inc.
  - .1 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - .2 ASTM A403, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
  - .3 ASTM A420, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service.
  - .4 ASTM B88, Standard Specification for Seamless Copper Water Tube.
  - .5 ASTM B.61, Standard Specification for Steam or Valve Bronze Castings.
- .4 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-B139 Installation Code for Oil-Burning Equipment.
  - .2 CSA B137.4, Polyethylene (PE) Piping Systems Fittings for Gas Services.
  - .3 CSA B149.1, Natural Gas and Propane Installation Code.
  - .4 ANSI LC4/CSA 6.32, Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems
- .5 Standards Council of Canada
  - .1 CAN/CGSB-1.181 Ready-Mixed Organic Zinc-Rich Coating.
- .6 NFPA
  - .1 NFPA 30 Flammable and Combustible Liquids Code.

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings: Submit shop drawings for all products specified in Part 2 of this Section except for the pipe and fittings.
- .3 Test Data: Submit piping system leakage test sheets as specified in Section 20 05 00 – General Mechanical Requirements.

### 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in its original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 PIPING, FITTINGS AND JOINTS

- .1 Coated Black Steel - Welded Joints: "Yellow Jacket" Schedule 40 mild black carbon steel, ASTM A53, Grade B, factory coated with yellow plastic, mill or site beveled, and complete with forged steel butt welding fittings and welded joints. All bare metal surfaces shall be cleaned and corrosion protected with a suitable Denso primer and tape corrosion protection system.
- .2 Polyethylene (PE): Safety yellow coloured polyethylene pipe, fittings and joints in accordance with CSA B137.4. Polyethylene piping shall be accompanied by a tracing wire or other electronically detectable tracing media.
- .3 Uncoated Black Steel - Screwed Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings in accordance with ASME B1.20.1, and screwed joints.
- .4 Uncoated Black Steel - Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site beveled, complete with factory made forged steel butt welding fittings and welded joints.
- .5 Uncoated Black Steel – Press Joints: Schedule 40 mild black carbon steel, ASTM A53, complete with cold press mechanical joint fittings conforming to the material requirements of ASTM A420 or ASME B31.9 and performance criteria of ANSI LC4/CSA 6.32. Sealing elements for pressing fittings shall be HNBR and shall be factory installed or supplied by fitting manufacturer. Press fittings shall feature a design leakage path, assuring leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. System to be rated to a minimum pressure of 500 kPa (72 psi) and a temperature range of -20°C to 70°C (-4°F to 158°F).
  - .1 Acceptable Manufacturers
    - .1 Viega LLC. "MegaPress G"
    - .2 Apollo Valves "PowerPress Gas"
- .6 Uncoated Copper: Type "K" seamless copper tubing in accordance with ASTM B88, hard temper with wrought copper capillary brazed joint type fittings in accordance with ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45o flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.
- .7 Coated Copper: Type "K" soft temper as above but with a factory applied external yellow plastic coating.

### 2.2 SHUTOFF VALVES

- .1 Ball Type: CSA certified, minimum 3100 kPa (450 psi) WOG rated, quarter turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends. Acceptable products are:
  - .1 Neo Valves Ltd. #525
  - .2 Kitz Corp. Code 58

- .3 Toyo Valve Co. Fig. 5044A
- .4 M.A. Stewart & Sons Ltd. MAS B-3
- .5 Nibco Inc. #T-FP-600
- .2 Plug Type: CSA certified, plain face flanged, Class 125, 1380 kPa (200 psi) rated, quarter turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle. Acceptable products are:
  - .1 Neo Valves Ltd. #1AS40114
  - .2 Newman Hattersley Ltd. #171M
  - .3 KITZ Corporation 150 SCTAM-FS (flanged, 150 class, ball valve, 13 mm to 250 mm (½" to 10")) CGA/CSA 3.16
- .3 Underground Ball Type and Valve Box: CSA B137.4 certified, minimum 690 kPa (100 psi) WOG rated, quarter turn, full port, non-lubricated, polyethylene (PE) ball valve. Each complete with a Nitrile (NBR) seat, acetal/Polypropylene ball, acetal stem, polypropylene operator nut, and butt or socket fusions ends. Each valve shall also be provided with a valve box, stem extension to allow for actuation from ground level. Acceptable Products are:
  - .1 Polyvalve Poly-Gas Valve
  - .2 Lyall HDPE 3408 Gas Valve
  - .3 AquaFuse PHS HDPE Gas Valve

## 2.3 PRESSURE REDUCING REGULATORS

- .1 Provide Fisher, Itron, Maxitrol, or Norgas Meter Technologies (NMT) pressure reducing regulators as indicated on the Contract Drawings. Also provide pressure reducing regulators to suit the building load complete with relief.

## 2.4 FLEXIBLE APPLIANCE CONNECTORS

- .1 Stainless Steel Flexible Hose: CSA certified, Annealed 304 stainless steel tubing coated in antimicrobial PVC or equivalent polymer, carbon steel flare nut and adapter coated with zinc trivalent chromate plating, multi-strain stainless steel protective braiding to be included on connectors for movable appliances.
  - .1 Connectors for moveable equipment to comply with ANSI Z21.69/CSA 6.16
  - .2 Connectors for stationary equipment to comply with ANSI Z21.24/CSA6.10
  - .3 Connectors for outdoor equipment to comply with ANSIZ21.75/CSA 6.27

## 2.5 NATURAL GAS SUB-METER

- .1 Provide a diaphragm type natural gas meter complete with integral or remote transmitter.
- .2 Transmitter output signal shall be a programmable pulse.
- .3 Meter shall be temperature compensated for better accuracy.
- .4 Meter shall meet ANSI B109.2 specification.
- .5 Meter shall be Measurement Canada accredited.
- .6 Acceptable Products are:
  - .1 Elster American Meter AL-425, AL-800, AL-1000 (depending on capacity)
  - .2 Or approved equivalent.

## 2.6 PIPING EXPANSION JOINTS

- .1 Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal hose, compatible braid, with inlet and outlet connections to suit.
  - .1 Corrugated Hose Stainless Steel Type 321 in accordance with ASTM A240
  - .2 Braid shall be 304 Stainless Steel in accordance with ASTM A240.
  - .3 Fittings Materials of construction
    - .1 Carbon steel shall be Standard weight / Sch 40 ASTM A 234 WPB
      - .1 End fittings shall match fittings material.
        - .1 Weld end in accordance with ASME B16.9
        - .2 NPT in accordance with ASME B1.20.1
      - .2 Stainless steel shall Sch 40 S Type 304 Stainless in accordance with ASTM A240
        - .1 End fittings shall match fitting material.
          - .1 Weld end in accordance with ASME B16.9
          - .2 MPT in accordance with ASME B1.20.1
  - .2 Flexible loops shall be capable of movement in the  $\pm X$ ,  $\pm Y$ , and  $\pm Z$  planes.
  - .3 Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.
  - .4 Flexible hose expansion loops for flammable liquid or gas service up to 4" shall be CSA / AGA listed and be in conformance with UL-536.
  - .5 All flexible hose expansion loops shall be manufactured in accordance with ASME / ANSI B31.1, and the documented manufacturers weld procedure specifications in accordance with ASME Section IX. Guiding and anchoring shall be as designed by the manufacturer, stamped by a Professional Engineer, and included with the submittals.
  - .6 Acceptable products are:
    - .1 The Metraflex Co., Metraloop (MLACT, MLACW).
    - .2 Mason Industries Inc, Vee Assembly (CSA Series).
    - .3 Flexicraft Industries, CSA/AGA ML Loop.

## 3 EXECUTION

### 3.1 NATURAL GAS SERVICE

- .1 Make all required arrangement with the natural gas supply utility for installation of natural gas service piping with gas pressure regulator and meter assembly where shown on the Drawings.

### 3.2 NATURAL GAS PIPING INSTALLATION REQUIREMENTS

- .1 Provide all required natural gas distribution piping and connect gas fired or operated equipment, and provide all required vent piping to the atmosphere, including vent piping from pressure regulators. Perform all piping work in accordance with the requirements of CSA International B149.1, Natural Gas and Propane Installation Code.

- .2 Piping shall be as follows:
  - .1 For underground piping, coated Schedule 40 black steel, soft copper, or polyethylene.
  - .2 For above ground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or if permitted, flexible stainless steel.
- .3 Install flexible stainless steel pipe in strict accordance with the pipe manufacturer's printed instructions.
- .4 Slope gas piping in the direction of flow to low points.
- .5 Provide full pipe diameter 150 mm (6") long drip pockets at the bottom of all vertical risers, at all piping low points, and wherever else shown and/or required by the Contract Documents.
- .6 Paint and identify all natural gas piping with two coats of safety yellow enamel paint applied over primer paint, and SMS Ltd. coil type vinyl identification makers with arrows.
- .7 Rough-in all required natural gas piping for kitchen equipment in accordance with drawing plans and schedules. Obtain accurately dimensioned rough-in drawings for the equipment and confirm the exact locations with the Consultant prior to roughing-in. When the equipment has been installed, connect the equipment from the roughed-in work. Provide shut-off valves in all piping connections to the equipment.
- .8 Where movable equipment is being installed or a rigid connection cannot be facilitated a flexible appliance connector shall be used.
- .9 Expansion and contraction allowance for piping:
  - .1 Ensure that there is adequate allowance for the expansion and contraction movements of all piping either by providing special expansion joints or by ensuring that sufficient allowance is inherent in the specified joints.
  - .2 Securely anchor piping at changes of direction and provide intermediate anchors located along long straight runs as necessary.
  - .3 Provide details and calculations regarding movements due to thermal expansion and contraction. Provide a summary data sheet listing all or most major pipe runs and show the calculated thermal expansion expected, the number, type and location of expansion couplings required.

### 3.3 **INSTALLATION OF SHUTOFF VALVES**

- .1 Provide CSA/TSSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown on the Drawings.
- .2 Ensure that valves are located for easy accessibility and maintenance.

### 3.4 **INSTALLATION OF UNDERGROUND VALVES AND VALVE BOXES**

- .1 Provide CSA/TSSA approved ball type to isolate the system where shown on the Drawings.
- .2 Ensure that valves are located for easy accessibility and maintenance.
- .3 Install valves and valve boxes plumb, centered over the operating nut and supported in place during backfilling with the cover flush with the finished grade.
- .4 Do not backfill until valves or valve boxes have been inspected by the Engineer, or the Inspector, or the Authority having jurisdiction.

### 3.5 **INSTALLATION OF GAS SUB-METER**

- .1 Provide non-utility gas meters as shown on the Drawings.
- .2 Install gas meter in accordance with manufacturer's instructions.

- .3 Coordinate connection of gas meter to BAS with Controls Contractor.

**END OF SECTION 23 11 23**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME)
  - .1 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
  - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - .4 ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
  - .5 ANSI/ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.
  - .6 ANSI/ASNE B31.9, Building Services Piping.
- .2 ASTM International Inc.
  - .1 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - .2 ASTM A105, Standard Specification for Carbon Steel Forgings for Piping Applications.
  - .3 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
  - .4 ASTM A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
  - .5 ASTM A743/A743A, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
  - .6 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .7 ASTM B88, Standard Specification for Seamless Copper Water Tube.
  - .8 ASTM B283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed).
  - .9 ASTM F492, Standard Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.
  - .10 ASTM F876, Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
  - .11 ASTM F877, Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems.
  - .12 ASTM F1960, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing.
  - .13 ASTM F1969, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing.
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-B137.5, Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications
  - .2 CAN/CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.



- .3 CAN/ULC-S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies
- .4 CAN/ULC-S115, Standard Method of Fire Tests of Firestop Systems
- .4 International Association of Plumbing and Mechanical Officials (IAPMO)
  - .1 IAPMO PS 117 Press and Nail Connections.
- .5 International Organization for Standardization (ISO)
  - .1 ISO 9001 Quality Management System Certification
- .6 National Building Code 2015 (NBC)

## 1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Provide the manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit WHIMS MSDS – Materials Safety Data Sheets.
- .3 Shop Drawings:
  - .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .4 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

## 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 HYDRONIC PIPING, FITTINGS AND JOINTS

- .1 Black Steel – Grooved Joint: Schedule 40, mild black carbon steel, Grade B, ASTM A53, factory or site roll grooved, complete with:
  - .1 Cast ductile iron grooved end fittings conforming to ASTM A536.
  - .2 Victaulic Style 07 "Zero-Flex", Victaulic Corporation Style 107 "QuickVic", Tyco Grinnell (Tyco Mechanical Products) Style 772, Anvil International, Gruvlok Fig. 7401 "Rigidlok" or Shurjoint Model Z07 rigid couplings for piping in the Mechanical Rooms and for piping risers, Victaulic Corporation Style 77, Tyco Grinnell (Tyco Mechanical Products) Style 707, Anvil International, Gruvlok Fig. 700 or Shurjoint (Tyco Mechanical Products) Model 7707 standard flexible couplings for all other piping.
  - .3 Gaskets shall be EPDM compound, rated -34° C to +110° C (-30° F to +230° F).
- .2 Black Steel – Screwed Joint: Schedule 40, mild black carbon steel, Grade B, ASTM A53, complete with Class 150 malleable iron threaded fittings to ANSI/ASME B16.3, and screwed joints.

- .3 Black Steel – Welded Joint: Schedule 40, mild black carbon steel, Grade B, ASTM A53, mill or site beveled, complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible, and welded joints.
- .4 Black Steel – Press Joint: Schedule 40, mild black carbon steel, Grade B, ASTM A53, complete with carbon steel fittings conforming to the performance criteria of IAPMO PS 117 and ASME B31.9. Sealing elements for pressing fittings shall be EPDM and shall be factory installed or supplied by fitting manufacturer. Press fittings shall feature a design leakage path, assuring leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. System to be rated to a minimum pressure of 1379 kPa (200 psi) and a temperature range of -18°C to 120°C (0F to 250°F).
  - .1 Acceptable Manufacturers
    - .1 Viega LLC. “MegaPress”
    - .2 Apollo Valves “PowerPress”
- .5 Copper – Solder Joint: Type “L” hard drawn seamless copper to ASTM B88, plain ends. All joints made with 95-5 tin-antimony or tin-silver solder.
- .6 Copper – Press Joint: Type “L” hard drawn seamless copper to ASTM B88, complete with wrought copper press fittings (ANSI/ASME B16.22) or cast copper alloy press fittings (ANSI/ASME B16.18) conforming to the performance criteria of IAPMO PS 117. Sealing elements for pressing fittings shall be EPDM and shall be factory installed or supplied by fitting manufacturer. Press fittings shall feature a design leakage path, assuring leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. System to be rated to a minimum pressure of 1379 kPa (200 psi) and a temperature range of -18°C to 120°C (0F to 250°F).
  - .1 Acceptable Manufacturers
    - .1 Viega LLC. “ProPress”
    - .2 Apollo Valves “Press”
    - .3 Nibco Inc. “Press Fittings”
- .7 Hydronic PEX :
  - .1 Tube Materials: Tube shall be cross-linked polyethylene (PEX) manufactured by PEX-a or peroxide method.
    - .1 PEX tubing shall be ASTM F876 tested and approved for excessive temperature and pressure for 725 hours at 210°F (99°C) @ 1035 kPa (150 psi).
    - .2 PEX tubing shall be manufactured in accordance with ASTM F876, ASTM F877 and CAN/CSA-B137.5. The tube shall be listed to ASTM by an independent third party agency.
    - .3 PEX tubing shall have Standard Grade hydrostatic design and pressure ratings of 82°C (200°F) at 551 kPa (80 psi), 82°C (180°F) at 689 kPa (100 psi), and 23°C (73.4°F) at 1102 kPa (160 psi). Temperature and pressure ratings shall be issued by the Plastic Pipe Institute (PPI), a division of the Society of the Plastic Industry (SPI).
    - .4 Minimum bend radius for cold bending of the PEX tubing shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by tube manufacturer.
  - .2 PEX tube dimensions 12 mm (½ in.) to 25mm (1 in.) shall be in accordance with ASTM F876 and ASTM F877.

- .3 When used in buildings of non-combustible construction all PEX tubing shall be listed to CAN/ULC S102.2, achieving a Flame Spread Rating not exceeding 25 and achieving a Smoke Developed Classification not exceeding 50. All conditions required to meet the listing shall be strictly adhered to (eg. minimum 457 mm (18 in.) spacing between PEX runs). The PEX tubing shall meet the Flame Spread Rating and Smoke Developed Classification as an independent component, using an addition component/material to meet these requirements is unacceptable (eg. plenum wrap, insulation, water-filled pipe, etc.). All firestops shall be approved by CAN/ULC-S115.
- .4 Pre-Sleeved Tubing: All PEX tubing that is encased in concrete shall be pre-sleeved in corrugated polyethylene tubing.
- .5 Fitting Materials: Fittings, including manifolds and multi-port tees, shall be manufactured of Engineered Polymer (EP). Stainless steel materials are allowed only for transition fittings. Fitting connections shall be made to the requirements of ASTM F1960.
- .6 Fittings shall be supplied by the PEX tubing manufacturer.
- .7 PEX-a cold expansion type fittings shall be an assembly consisting of insert and PEX-a cold expansion ring.
- .8 Acceptable Manufacturers:
  - .1 Uponor Ltd.
  - .2 Rehau Group

## 2.2 PIPING UNIONS

- .1 Screwed Steel Piping: Dart Union Co. of Canada Ltd. or approved equivalent malleable iron, ground joint, 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 Press Steel Piping: Viega MegaPress union or approved equivalent carbon steel press connection with a minimum pressure rating of 1379 kPa (200 psi) at a temperature range - 18°C to 120°C (0°F to 250°F).
- .3 Welded Steel Piping: Forged carbon steel slip-on type raised face welding flange unions in accordance with ASTM A105, 150 lb. Class.

## 3 EXECUTION

### 3.1 HYDRONIC PIPING MATERIAL AND JOINT TYPES

- .1 Heating water piping, Chilled water piping and Glycol water piping; unless otherwise specified, is to be as follows:
  - .1 For pipe up to 50 mm (2 in.) diameter, Schedule 40 Black Steel – Screwed Joint. As an alternative Schedule 40 Black Steel – Press Joint, Type “L” Copper - Press Joint, and Type “L” Copper – Solder Joint may be used.
  - .2 For pipe 65 mm (2.5 in.) in diameter and larger Schedule 40 Black Steel – Grooved Joint. As an alternative Schedule 40 Black Steel – Welded Joint may be used.
  - .3 For radiant floor heating equipment, when pipe diameters are less than 25 mm (1 in.) and when working pressures are below 1034 kPa (150 psi) Hydronic PEX piping may be used as an acceptable alternative.

### 3.2 GENERAL PIPING INSTALLATION REQUIREMENTS

- .1 Install all piping so that it can be completely drained. Horizontal piping mains to be sloped to provide a minimum continuous up-grade of 25 mm (1") in 12 m (40') to high points (0.2%),

wherever practicable. Branch supply and return piping connections to be sloped towards equipment a minimum of 25 mm (1") in 12 m (40') to low point (0.2%), wherever practicable. Leave sufficient room at high points for installation of air vents. In locations where sloping is not practicable, and the system cannot be drained by gravity additional drainage points and compressed air connection points shall be added to the system to allow for the system to be "blown-out" via portable air compressor.

- .2 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 in Section 25 05 00 – Building Automation System.
- .3 Connect equipment provided as part of the Work of other Sections with piping as indicated in and/or required by the Contract Drawings. Refer to pipe connection details on Drawings.
- .4 Unless otherwise specified in the Contract Documents, locate and arrange horizontal pipes above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained.
- .5 Unless otherwise specified in the Contract Documents, install all work concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Note that walls which are painted are considered finished.
- .6 Install all pipes and ducts parallel to building lines (all piping shall run parallel with closest wall).
- .7 Piping in walk-in pipe spaces shall be installed as close to one wall as possible.
- .8 Neatly group and arrange all exposed work.
- .9 Locate all valves and any other equipment which will or may need maintenance or repaired in accessible spaces, equipment shall be easily accessible from access doors. Where valves and similar piping accessories occur in vertical service spaces (ie. in shafts, pipe spaces or partitions) locate the accessories at the floor level.
- .10 Make all connections between pipes of different materials using proper approved adapters. Provide proper dielectric unions in all connections between copper pipe and ferrous pipe or equipment. Dielectric fitting to conform to ASTM F492 complete with thermoplastic liner.
- .11 Ensure that the equipment and material manufacturers' installation instructions are followed unless otherwise specified in this Section or on the Drawings, and unless such instructions contradict governing codes and regulations.
- .12 Carefully clean all pipes and fittings prior to installation. Temporarily cap or plug ends of pipes and equipment which are open and exposed during construction.
- .13 Install piping which is to be insulated so that they have sufficient clearance to permit insulation to be applied continuously and unbroken around the pipe, except at fire barriers, in which case the insulation will be terminated at each side of the fire barrier.
- .14 Inspect surfaces and structure prepared by other trades before performing the work of this Section. Verify that surfaces or the structure to receive the work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing to the Consultant. Installation of the work shall constitute the Contractor's acceptance of such surfaces as being satisfactory.

### 3.3 PIPE JOINT REQUIREMENTS

- .1 For pipes travelling perpendicular (through) wall or slabs do not make pipe joints inside the wall or slab. Pipe joints can be made inside a wall while the pipe is travelling parallel to the wall, concealed inside.

- .2 Ream all piping ends prior to making joints.
- .3 Properly cut threads in screwed steel piping and coat male threads, unless otherwise specified in the Contract Documents, with red lead, Teflon tape or paste, or an equivalent thread lubricant. After the pipe has been screwed into the fitting, valve, union, or piping accessory, not more than two pipe threads are to remain exposed.
- .4 Unless otherwise specified in the Contract Documents, make all soldered joints in copper piping using flux suitable for and compatible with the type of solder being used. Clean the outside of the pipe end and the inside of the fitting, valve, or similar accessory prior to soldering.
- .5 Install mechanical joint fittings and couplings in accordance with the manufacturer's instructions.
- .6 If grooved fittings and couplings are used, ensure that all valves and piping accessories are suitable. Grooves shall be rolled. Make arrangements with the coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to the manufacturer's instructions with respect to pipe grooving, support, anchoring and guiding the grooved piping system. Note that all grooved end piping system products shall be supplied by a single manufacturer who is operating to an ISO 9001 program.

#### 3.4 **PRESSURE TESTS**

- .1 Conform to requirements of Section 20 05 93 – Testing, Adjusting, and Balancing (TAB).

**END OF SECTION 23 21 13**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME)
  - .1 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
  - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - .4 ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
  - .5 ANSI/ASME B16.4, Cast Iron Threaded Fittings, Classes 125 and 250.
  - .6 ANSI/ASNE B31.9, Building Services Piping.
- .2 ASTM International Inc.
  - .1 ASTM A105, Standard Specification for Carbon Steel Forgings for Piping Applications.
  - .2 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
  - .3 ASTM A743/A743A, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
  - .4 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .5 ASTM B283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed).
  - .6 ASTM F1969, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing.
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
  - .2 CAN/ULC-S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies
  - .3 CAN/ULC-S115, Standard Method of Fire Tests of Firestop Systems
- .4 National Building Code 2015 (NBC)

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Provide the manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit WHIMS MSDS – Materials Safety Data Sheets.
- .3 Shop Drawings:
  - .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .4 Closeout Submittals:

- .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

### 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 - Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 SHUT-OFF VALVES

- .1 Ball Type for nominal pipe sizes from 12 to 50 mm ( $\frac{1}{2}$ " to 2"): 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 or press joint ends, and removable lever handle. Where piping is insulated provide stem extensions to clear insulation. Acceptable products are:
  - .1 Kitz Corp. Code 858
  - .2 Toyo Valve Co. Fig.5044ALF
  - .3 MAS #B-3LF
  - .4 Nibco T-585-80-LF
  - .5 Watts Water Technologies (Canada) Inc. FBV-3C
- .2 Butterfly Type for nominal pipe sizes 65 mm (2-1/2") and larger: Ductile iron, lug body style or grooved, 1200 kPa (175 psi) rated, butterfly valve, each complete with a neck to permit 50 mm (2 inches) of insulation above the flange, an EPDM seat, aluminum bronze or stainless steel disc, stainless steel shaft with EPDM seal, a lever handle for valves to and including 100 mm (4 inch) diameter, and a handwheel and gear type operator for valves larger than 100 mm (4 inch) diameter and each suitable for bubble-tight dead end service with the valve in position and either side of the connecting piping removed. Where piping is insulated provide stem extensions to clear insulation. Acceptable products are:
  - .1 Kitz Corp. Code 6122EL or 6122EG
  - .2 Toyo Valve Co. #918 BESL-2 or 918 BESG-2
  - .3 Nibco # LD-2000
  - .4 Equivalent manufacturers: Apollo Valves, Viega, Victaulic, Tyco Grinnell, M.A. Stewart & Sons, DeZurik of Canada Ltd.

### 2.2 SWING CHECK VALVES

- .1 Bronze – Screwed: 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. Acceptable products are:
  - .1 Kitz Corp. Code No. 22
  - .2 Toyo Valve Co. Fig. 236
  - .3 Nibco #T-413
  - .4 Equivalent manufacturers: Apollo Valves, Watts Water Technologies (Canada) Inc.

- .2 Steel – Grooved Ends: Victaulic Co. of Canada Ltd. Series 716 "Vic-Check", Tyco Grinnell Model 590, Gruvlok Series 7811 or Shurjoint #SJ-900 grooved end carbon steel check valves suitable for mounting horizontally or vertically.
- .3 Cast Iron –Flanged: 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 flanged ends as required. Acceptable products are:
  - .1 Kitz Corp. Code No. 78
  - .2 Toyo Valve Co. Fig. 435A
  - .3 Nibco #F-918-B
  - .4 Equivalent manufacturers: Apollo Valves, Watts Water Technologies (Canada) Inc.

## 2.3 VERTICAL LIFT CHECK VALVES

- .1 Class 125, 1380 kPa (200 psi) WOG rated bronze vertical lift check valves, each complete with screwed ends and a bronze disc. Acceptable products are:
  - .1 Kitz Corp. Code No. 36
  - .2 Toyo Valve Co. Fig. 231
  - .3 Nibco #T-480
  - .4 Watts Water Technologies (Canada) Inc. #LF600
  - .5 Equivalent manufacturers: Apollo Valves, Viega, M.A. Steward & Sons.

## 2.4 WAFER CHECK VALVE

- .1 Threaded lug body type, full bore, Class 125, 1380 kPa (200 psi) rated at 38 degrees C (100 degrees F), non-slam dual wafer check valves, each complete with a carbon steel or cast iron 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. Acceptable products are:
  - .1 Nibco #W-920
  - .2 The Metraflex Co. Style CVXX
  - .3 Watts Water Technologies (Canada) Inc. Series #ICV-125
  - .4 Equivalent manufacturers: Crane Valve Co, Mueller Steam Specialty, Gulf Valve Co.

## 2.5 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) WOG rated, 20 mm (3/4-inch) diameter straight pattern full port bronze or brass ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (3/4-inch) diameter garden hose, and a cap and chain. Acceptable products are:
  - .1 Kitz Corp. Code No. 68AC
  - .2 Toyo Valve Co. Ltd. Fig. 5046
  - .3 Nibco # T-585-70-HC
  - .4 Watts Regulator #B-6000-CC
  - .5 Equivalent manufacturers: Apollo Valves.

## 2.6 CIRCUIT BALANCING VALVES

- .1 Valves 12 to 50 mm (1/2 to 2 in.) 'Y' pattern, equal percentage globe-style and provide three functions: 1) Precise flow measurement, 2) Precision flow balancing, 3) Positive drip-tight shut-off. Valves shall provide multi-turn, 360 degree adjustment with micrometer type



indicators located on the valve handwheel. Valves shall have a minimum of five full 360 degree handwheel turns. 90 degree 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 6.35 mm (1/4 in.) threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin.

- .2 Valves 65 to 300 mm (2-1/2 to 12 in.) 'Y' pattern, equal percentage globe-style and provide three functions: 1) Precise flow measurement, 2) Precision flow balancing, 3) Positive drip-tight shut-off. Valves shall provide multi-turn, 360 degree adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360 degree handwheel turns. 90 degree 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. Valve body shall be either cast iron with integrated cast iron flanges or ductile iron with industrial standard grooved ends. Valve stem and plug disc shall be bronze with ergonomically designed handwheel that permits multi-turn adjustments. Sizes 65 and 75 mm (2-1/2 and 3 in.) – 5 turns; sizes 100 mm to 150 mm (4 to 6 in.) – 6 turns; sizes 200 and 250 mm (8 and 10 in.) – 12 turns and size 300 mm (12 in.) – 14 turns. Flange adapters shall be supplied, to prevent rotation.
- .3 Acceptable products are:
  - .1 Armstrong Fluid Technology. Series "CBV" screwed, flanged or grooved
  - .2 Victaulic Co. of Canada Ltd. (Tour & Anderson) Series 787 screwed, Series 788 flanged, and 789 grooved end
  - .3 Tyco Grinnell Series CB800 screwed, flanged, or grooved end
  - .4 Gruvlok series "GBV" screwed or grooved
  - .5 RWV #9517 screwed or 9474P flanged

## 2.7 AUTOMATIC FLOW LIMITING VALVES

- .1 Valves 12 to 50 mm (1/2 to 2 in.) 'Y' pattern, pressure independent, cartridges shall be stainless steel with a spring loaded cup designed to dynamically absorb pressure fluctuations resulting from changes in system conditions due to varying heating/cooling loads. Flow shall be controlled within +/- 5% of the design flow, with a WOG rating of no less than 300 psi. Valves shall arrive fully assembled and include:
  - .1 Cartridge: AISI Type 304 stainless steel cartridge complete with an AISI Type 17-7 PH stainless steel spring.
  - .2 Strainer: 20 mesh stainless steel.
  - .3 Body Material: 12 to 40 mm (1/2 to 1-1/2 in.) to be constructed of forged brass (ASTM B283), 40 to 50 mm (1/2 to 1-1/2 in.) to be constructed of cast brass.
  - .4 End Connections: Brass – NPT, Sweat or Press joint.
  - .5 Ball Valve Seals: Teflon
  - .6 Union Seal: EPDM O-Ring
  - .7 Body Tappings: Port 1 and 2 shall be combination P/T test valves and manual air vent; Port 4 shall be a drain.
  - .8 Ball Valve: Nickel-plated brass ball.

- .2 Valves 65 to 75 mm (2-1/2 to 3 in.) 'R' pattern, pressure independent, cartridges shall be stainless steel with a spring loaded cup designed to dynamically absorb pressure fluctuations resulting from changes in system conditions due to varying heating/cooling loads. Flow shall be controlled within +/- 5% of the design flow, with a WOG rating of no less than 300 psi. Valves shall arrive fully assembled and include:
  - .1 Cartridge: AISI Type 304 stainless steel cartridge complete with an AISI Type 17-7 PH stainless steel spring.
  - .2 Body Material: To be constructed of cast brass.
  - .3 End Connections: Brass – NPT, Sweat or Press joint.
  - .4 Ball Valve Seals: Teflon
  - .5 Union Seal: EPDM O-Ring
  - .6 Body Tappings: Port 1 and 2 shall be combination P/T test valves and manual air vent.
  - .7 Ball Valve: Nickel-plated brass ball.
- .3 Valves 75 mm (3 in.) and up, Class 300 type, pressure independent, cartridges shall be stainless steel with a spring loaded cup designed to dynamically absorb pressure fluctuations resulting from changes in system conditions due to varying heating/cooling loads. Flow shall be controlled within +/- 5% of the design flow. Valves shall arrive fully assembled with flange adapters to prevent rotation and include:
  - .1 Cartridge: AISI Type 304 stainless steel cartridge complete with an AISI Type 17-7 PH stainless steel spring.
  - .2 Body Material: Steel pipe schedule 40.
  - .3 End Connections: Flanged.
  - .4 Body Tappings: Port 1 and 2 shall be combination P/T test valves and manual air vent.
- .4 Acceptable manufacturers:
  - .1 Griswold Controls LLC.
  - .2 Hays Fluid Controls.
  - .3 Bell & Gossett (Xylem Inc.)

## 2.8 PRESSURE RELIEF VALVES

- .1 ASME tested, rated, and certified, bronze or cast iron bronze fitted, 1035 kPa (150 psi) rated pressure relief valves, each capable of relieving the full output of the equipment it is associated with, and each factory set at the pressure as noted in Part 3 of this specification. Acceptable products are:
  - .1 Bell & Gossett (Xylem Inc.), 3301/4100, or 790/1170
  - .2 Spirax Sarco Ltd. SVI Series
  - .3 Watts Water Technologies (Canada) Inc. 174A or 740
  - .4 Equivalent manufacturers: Dresser Industries, McDonnell & Miller, Conbraco, Kunkel.

## 2.9 AIR VENTS

- .1 Manual Air Vents: Apollo Valves (Johnson Paterson) 27-Series or approved equivalent, 3.2 mm (1/8-inch) dia. manual valve with key.
- .2 Automatic Air Vents: Float actuated air vents, each complete with a brass or cast-iron body and cap, a copper or stainless-steel float assembly and seat, and an EPDM or PTFE valve

head/seal. Minimum working and venting pressure shall be 1035 kPa (150 psi). Acceptable products are:

- .1 Spirax Sarco Ltd., Type 13 WS for system working pressures to 1035 kPa (150 psi), 13WH for system working pressures greater than 1035 kPa (150 psi)
- .2 Armstrong International, No. 1-AV
- .3 Bell & Gossett (Xylem Inc.), Hoffman Specialty Model 792
- .4 Maid-O-Mist, No. 75.

#### 2.10 AIR SEPARATOR

- .1 Vortex type vertical air separator with side tangential inlet and outlet connections, a top air outlet connection, and bottom drain connection. The separator shall 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 I of the ASME Boiler and Pressure Vessel Code.
  - .1 Acceptable products are:
    - .1 Armstrong Fluid Technology, Model "VA"
    - .2 Bell & Gossett (Xylem Inc.), "Rolairtrol"
  - .2 Coalescing medium type air separator with side tangential inlet and outlet connections, a top air outlet connection, bottom drain connection. The separator shall be constructed of brass, cast iron, or fabricated steel and suitable for a working pressure of 1034 kPa (150 psi) at 115°C (240°F).
    - .1 Acceptable products are:
      - .1 Spirotherm Inc., Spirovent Junior Microbubble Eliminator
      - .2 Bell & Gossett (Xylem Inc.), "Enhanced Air Separator"
      - .3 Watts Water Technologies (Canada) Inc., AS-MB

#### 2.11 HYDRAULIC SEPARATORS

- .1 Separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include three performance chambers within the vessel. One chamber above the higher nozzle set for air elimination, one below the lower nozzle set for dirt separation, and one between the nozzles for hydraulic separation. The vessel diameter, height above and below the nozzles, and distance between the nozzles must be equal to the basis of design (Spirovent Quad® Series VDX as manufactured by Spirotherm).
- .2 Unit shall include internal elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements must consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism. Optional removable lower head for internal inspection shall be included for pipe sizes 100mm (4 in.) and larger.
- .3 Acceptable products are:
  - .1 Spirotherm Spirovent Quad®
  - .2 Caleffi HydroCal

#### 2.12 STRAINERS

- .1 Cast iron or bronze wye shaped strainers, minimum 860 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 inch) diameter and larger, a blowdown pipe connection tapping. Acceptable products are:

- .1 Kitz Fig. 15 screwed or Fig. 80 flanged
- .2 Toyo Valve Co. Ltd. Fig. 380A screwed or Fig. 381 flanged
- .3 Watts Water Technologies (Canada) Inc. #77SCI
- .4 Victaulic Co. of Canada Style 732 "Vic-Strainer"
- .5 Equivalent manufacturers: Spirax Sarco Ltd., Muller Steam Specialties, Tyco Grinnell, Gruvlok, Shurjoint.

## 2.13 PIPING "V-LOOP" EXPANSION JOINTS

- .1 Piping and equipment connections shall be protected against seismic damage by the insertion of braided flexible hose.
- .2 Vee assemblies shall be rated for  $\pm 4"$  (100mm) seismic motion in all planes. Should the application include  $\pm 6"$  (150mm) thermal movement or thermal movement alone, install the Vee so the thermal movement is axial.
- .3 All submittals shall include a recognized test report, covering the full range of the specified movements at the operating pressures.
- .4 Vees shall have a minimum burst pressure of four times their rated pressure.
- .5 Vees in steel lines shall have stainless hose and braid with threaded ends, grooved ends, weld ends or floating flanges. In stainless lines, all fittings in contact with the media must be stainless as well. Copper lines, bronze hose and braid with copper or bronze fittings. Guiding and anchoring shall be as designed by the manufacturer, stamped by a Professional Engineer and included with the submittals.
- .6 Acceptable products are:
  - .1 Mason Industries Inc, Vee Assembly.
  - .2 Hyspan Precision Products, Series 4500 V-flex.
  - .3 The Metraflex Co., Metraloop V-loop.
  - .4 Equivalent manufacturers: Senior Flextronics Inc.

## 2.14 PIPING EXPANSION JOINTS:

- .1 Threaded, grooved or flanged expansion joints with multi-ply ASTM A240 T304 stainless steel bellows, A53 GRB carbon steel outer housing and anti-torque device. Each expansion joint is to be designed and detailed by the manufacturer. Submit shop drawings and calculations provided by the manufacturer for review. Acceptable products are:
  - .1 Senior Flexonics Ltd. Model "H2-MMT" 50 mm (2 inches) and smaller or Model "SX" 65 mm (2-1/2 inches) and larger
  - .2 The Metraflex Co. Model "HP2" 50 mm (2 inches) and smaller or Model "METRAGATOR" 65 mm (2-1/2 inches) and larger
  - .3 Hyspan Series "8500" 50 mm (2 inches) and smaller or Series "3500" 65 mm (2 1/2 inches) and larger

## 2.15 PIPING ALIGNMENT GUIDES

- .1 Prime coat painted black carbon steel pipe alignment guides sized and fabricated to suit the pipe size and the pipe insulation thickness. Acceptable products are:

- .1 Mason Industries Inc. Series SPG.
- .2 Hyspan Precision Products, Series 9500.
- .3 The Metraflex Co. Style IV.
- .4 Equivalent manufacturers: Senior Flextronics Inc., E. Myatt & Co, Anvil Inc., Empire Tool & Mfg. Inc.

## 2.16 PIPE ANCHORS

- .1 Welded structural black steel anchors of a size and type to securely anchor the pipe at the point shown. Each anchor is to be designed and detailed by a Professional Engineer registered in the Province of Ontario. Submit anchor shop drawings, stamped by the Professional Engineer for review.

## 2.17 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. Acceptable products are:
  - .1 Thorburn Equipment Inc. corrugated metal hose.
  - .2 Senior Flexonics Inc. A1 and A6 Series.
  - .3 The Metraflex Co., flexible metal hose.
- .2 As an alternative to metal hose assemblies, flexible grooved couplings may be used, contingent upon the following:
  - .1 Submit vendor specific application report identifying the flexible coupling used and their vibration and noise attenuation performance relative to connectors specified in clause A above for each pump application and actual pump speed across entire operational range.
  - .2 The quantity of flexible grooved couplings and the overall installation details, length of the assembly.
  - .3 The alternative system vibration and noise attenuation performance shall be reviewed by the Acoustical Engineer for acceptance.
  - .4 Materials, pressure and temperature to suit hydronic system it serves, and environmental conditions is installed in.
  - .5 Acceptable products: Victaulic Flex Couplings or equivalent.

## 2.18 PEX SYSTEM ACCESSORIES

- .1 Shut-Off Valves and Balancing Valves: PEX system valves shall be supplied by the PEX tubing manufacturer.
- .2 Tubing Wall Penetration Brackets: Brackets designed for tubing wall membrane penetrations shall be supplied by PEX tubing manufacturer.

## 3 EXECUTION

### 3.1 INSTALLATION OF SHUT-OFF VALVES

- .1 Provide shut-off valves in piping connections to equipment, on branch line connections to mains, on each piping riser, at 30 m (100 foot) intervals on main lines, and wherever else indicated on the Drawings.

- .2 Valves in piping to and including 50 mm (2 inch) diameter are to be ball type. All other shut-off valves are to be ball or butterfly type unless otherwise specified.
- .3 Locate all valves so that they are easily accessible. Wherever possible, install valves at uniform height. Provide chain operators for valves which are inaccessible for operation from floor level.

### 3.2 INSTALLATION OF CHECK VALVES

- .1 Provide a check valve in the discharge piping of every pump, and elsewhere in piping where shown on the Drawings.
- .2 In horizontal piping swing or vertical lift check valves shall be used. Where check valves are required in vertical piping, ensure that they are suitable in all respects for the application; vertical lift check valves shall be used wherever possible.
- .3 Wafer check valves may be used as an alternative to swing check valves when necessary.
- .4 Note that check valves for vertical in-line and/or base mounted circulating pumps are integral with the discharge accessory supplied with the pump.

### 3.3 INSTALLATION OF DRAIN VALVES

- .1 Provide a drain valve at the base of each piping riser, in drain connections to equipment, in low points of horizontal piping, and wherever else shown and/or specified.

### 3.4 INSTALLATION OF CIRCUIT BALANCING VALVES

- .1 Provide circuit balancing valves in piping connections to all equipment not served by a pressure independent control valve. Including but not limited to, heat exchangers (both circuits), boilers, chillers, cooling towers, pumps, 3-way control valves (2 ports), by-pass around control valves, etc.
- .2 Equipment served by pressure independent controls valves do not require circuit balancing valves, including but not limited to coils, cabinet & unit heaters, radiators, baseboards, fin-tube heaters, radiant ceiling panels
- .3 Provide circuit balancing valves on major branch line connections (serving 20 pieces of equipment or more) to mains, on each piping riser, and wherever else indicated on the Drawings.
- .4 Confirm locations with consultant prior to installation.

### 3.5 INSTALLATION OF AUTOMATIC FLOW LIMITING VALVES

- .1 Provide automatic flow limiting valves, as an alternative to circuit balancing valves and where required by these specifications and the drawings.
- .2 Confirm locations with consultant prior to installation.

### 3.6 INSTALLATION OF PRESSURE RELIEF VALVES

- .1 Provide factory set pressure relief valves in all closed loop HVAC systems wherever else shown on the drawings.
  - .1 For glycol filled systems, pipe the discharge of each relief valve to the glycol make-up package storage tank unless otherwise shown or specified.
  - .2 For water-filled systems, pipe the discharge from each relief valve to a funnel floor drain. Provide an air gap at the discharge.
- .2 Pressure relief valve settings shall be selected based on the following order of priority:
  - .1 As noted on the drawings.
  - .2 The relief pressure specified for the loop's expansion tank.

.3 10% lower than the component in the system with the lowest pressure rating.

.3 Confirm all pressure relief valve settings with the consultant prior to purchase and installation.

### 3.7 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. Install vents in accordance with the Drawing detail(s).

### 3.8 INSTALLATION OF AIR SEPARATOR

.1 Provide an air separator in the piping main where shown on the Drawings and connect with valved inlet and outlet piping. Secure in place in accordance with the manufacturer's instructions.

.1 Use a vortex style air separator for system flows larger than 75 lpm (20 gpm) or pipe sizes 50mm (2") and larger.

.2 Use a coalescing medium style air separator for system flows of 75 lpm (20 gpm) or less, and pipe sizes less than 50mm (2").

.2 Extend valved blowdown piping from the bottom pipe connection tapping to the nearest floor drain location.

.3 Equip the top pipe connection tapping with an automatic air vent, and piping as detailed on the Drawings.

### 3.9 INSTALLATION OF HYDRAULIC SEPARATOR

.1 Furnish and install as shown on the Drawings a full flow coalescing type combination air eliminator, dirt separator, hydraulic separator for the hot and chilled water systems.

.2 Selection shall be based upon system flows with pipe size as a minimum in accordance with the basis of design.

### 3.10 INSTALLATION OF STRAINERS

.1 Provide strainers in piping where shown.

.2 Locate strainers so that baskets are easily accessible and removable.

.3 Clean strainer baskets after piping system flushing and cleaning is complete, and before water quantity balancing commences.

### 3.11 INSTALLATION OF "V-LOOP" EXPANSION JOINTS AND PIPE GUIDES

.1 Provide expansion joints in the piping at the building expansion joints and wherever else shown on the Drawings.

.2 Install in accordance with the manufacturer's instructions.

.3 Provide pipe alignment guides where shown, including double guides at each side of expansion compensators, with exact locations in accordance with the expansion compensator supplier's recommendations.

### 3.12 INSTALLATION OF PIPE ANCHORS

.1 Provide anchors to secure pipework to the structure where shown and/or specified.

.2 Anchors are to be in accordance with reviewed shop drawings.

**END OF SECTION 23 21 16**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME BPVC, Boiler & Pressure Vessel Code.
- .2 National Building Code 2015 (NBC)

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Provide the manufacturer's printed product literature and datasheets for expansion tanks and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 EXPANSION TANK

- .1 Application
  - .1 For use in closed heating water and chilled water hydronic systems to control pressure build-up and protect the water heater.
  - .2 Accepts expanded water as system temperature rises and returns hot water to system when demand occurs.
  - .3 Provide sizes/capacities as per the "Hydronic Expansion Tank Schedule" below.
- .2 Construction
  - .1 Shell & Liner: High strength carbon steel shell complete.
  - .2 Bladder: Replaceable, heavy duty fixed butyl (EPDM).
  - .3 System Connection: NPT Stainless Steel.
  - .4 Air Valve: Projection welded 302"-32NC charging valve and cap
  - .5 Finish: Red Oxide Primer, Enamel Paint, or Epoxy Paint
  - .6 Factory Pre-charge: 12 PSIG (0.83 bar)
  - .7 The tank shall be fitted with lifting rings and a floor mounted skirt for vertical installations.
  - .8 The tank must be constructed in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.



- .3 Performance
  - .1 Max. Operating Temperature: 240° F (115° C)
  - .2 Max. Working Pressure: 125 PSIG (8.55 bar)
- .4 Acceptable Manufacturers
  - .1 Amtrol Inc.
  - .2 Wessels Company.
  - .3 Watts Industries (Canada) Inc.
  - .4 Bell & Gossett Inc. (Xylem Inc.)
  - .5 Armstrong Fluid Technology Ltd.
  - .6 Taco
  - .7 Calefactio

### 3 EXECUTION

#### 3.1 INSTALLATION OF EXPANSION TANK

- .1 Provide expansion tank on the suction side of circulator as shown on the Drawings and Schematics.
- .2 Install a shut-off valve and pressure gauge on incoming line for servicing and pressure equalization.
- .3 Before filling, complete pre-charge equalization between the expansion tank and closed loop system pressure. Final air charge shall match the resultant pressure of 10 PSI at the top most point of the system.
- .4 Secure each tank stand to a concrete housekeeping pad by means of machine bolts. Connect each tank with system piping as indicated on the Drawings.
- .5 Provide a drain valve and extend a drain line from each tank piping as indicated on the Drawings and terminate each drain line to nearest floor drain.
- .6 Provide a water make-up connection line complete with pressure reducer, backflow preventer, relief valve and pressure gauge for each tank and connect to system piping as shown on the Drawings. Terminate the make-up piping for connection to potable cold water piping as part of the work of Section 22 11 16. Check relief valve operation and adjust as required.
- .7 Follow all manufacturer recommendations.

**END OF SECTION 23 21 17**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).
  - .1 Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2 ASHRAE 189.1P Standard for the Design of High-Performance Green Buildings.
- .2 Canadian Standards Association (CSA International).
  - .1 CAN/CSA-B214, Installation Code for Hydronic Heating Systems.
- .3 Electrical Equipment Manufacturers Advisory Council (EEMAC).
- .4 Institute of Electrical and Electronics Engineers (IEEE)
  - .1 IEEE 519 Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.
- .5 National Electrical Manufacturers Association (NEMA).
  - .1 NEMA MG 1, Motors and Generators.
- .6 Underwriters Laboratories (UL)
  - .1 UL778 Standard for Motor-Operated Water Pumps.

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings: Submit shop drawings for all products specified in this Section. Shop drawings shall include all components including but not limited to, motor shop drawings, pump seals, accessories.
- .3 Submit certified performance curves with pump shop drawings. Illustrate the specified operating point, (or points, where multiple operating points are specified).
- .4 Submit the Manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .5 Start-up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements of Section 01 91 00 – Commissioning Specifications and Section 20 05 93 – Testing, Adjusting, and Balancing (TAB).

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling.
- .2 Remove from Site and dispose of packaging materials at the appropriate recycling facilities.

2 PRODUCTS

2.1 CIRCULATING PUMPS:

- .1 Bronze fitted centrifugal pumps in accordance with the Drawings schedule, each non-overloading under all operating conditions and factory tested at specified operating conditions.
- .2 A heavy-duty, radially split, gasketed cast iron volute designed for servicing and removal of the rotating assembly without disturbing pipe connections, and complete with plugged tapings for gauge and drain.

- .3 A balanced bronze impeller secured to a carbon steel shaft equipped with a stainless steel shaft sleeve.
- .4 Ball type, heavy-duty, lifetime lubricated, sealed bearings with back pull-out design bearing frame.
- .5 A TEFC motor conforming to requirements specified in Section 20 05 00.
- .6 A watertight John Crane Inc. JC2, OPID1 carbon rotating face type mechanical seal with tungsten carbide stationary seat, viton secondary seal and alloy 20 springs, and bronze gland plate with stainless steel gland bolts to secure the stationary seat.
- .7 Acceptable base mounted pumps are:
  - .1 Armstrong Fluid Technology
  - .2 Xylem Bell & Gossett

## 2.2 CLOSE COUPLED VERTICAL IN-LINE PUMP(S):

- .1 Close coupled, single stage vertical in-line pump(s) complete with:
  - .1 Close coupled type pumps shall be used for pumps 7.5 hp and smaller.
  - .2 A radially split, gasketed cast iron volute with equally sized suction and discharge flanged connections, and tapings for gauge, drain and flush line connections;
  - .3 A dynamically balanced bronze impeller with bronze shaft sleeve, secured to the motor shaft;
  - .4 A TEFC motor conforming to requirements specified in Section 20 05 00;
  - .5 A watertight John Crane Inc. #JC 8B2m XO1D1 or Durmetallic #RA EU5-FV carbon rotating face type inside mechanical seal with tungsten carbide stationary seat, viton secondary seal and alloy 20 springs, and bronze gland plate with stainless steel gland bolts to secure the stationary seat;
  - .6 Factory installed seal flush line tubing with 50 micron Cuno cartridge type filter with 12 extra cartridges (per pump), a sight flow indicator, and tubing valves.
- .2 Acceptable close coupled vertical in-line pumps are:
  - .1 Armstrong Fluid Products
  - .2 Bell & Gossett Ltd.
  - .3 Taco
  - .4 Flo-Fab
  - .5 Grundfos

## 2.3 SPLIT COUPLED VERTICAL IN-LINE PUMP(S):

- .1 Split Coupled Vertical In-Line Pump(s): Split coupled, single stage, vertical in-line pump(s) complete with:
  - .1 Split coupled type pumps shall be used for pumps 10 hp and larger.
  - .2 A radially split, gasketed cast iron volute with equally sized suction and discharge flanged connections, tapings for gauge, drain and flush line connections, and a cast iron motor mount bracket;
  - .3 A dynamically balanced cast bronze impeller secured to a Type 416 stainless steel shaft which is connected to the motor by means of a high tensile strength aluminum bar split type spacer coupling with guard designed to permit servicing of the mechanical, seal without disturbing the pump, motor, or electrical wiring;

- .4 A TEFC motor conforming to requirements specified in Section 20 05 00;
- .5 An Armstrong watertight #8A2 outside balanced design mechanical seal with Carbon versus Silicon Carbide faces, viton secondary seal and alloy 20 springs, and bronze gland plate with stainless steel gland bolts to secure the stationary seat. Alternately a watertight John Crane Inc. #JC8B2, XP1D1 or Flowserve #RA EU5-FV outside balanced type mechanical seal, with carbon versus tungsten carbide faces, viton secondary seal and alloy 20 springs, and bronze gland plate with stainless steel gland bolts to secure the stationary seat may be supplied;
- .6 A factory installed seal flush line tubing with 50 micron Cuno cartridge type filter with 12 extra cartridges (per pump), a sight flow indicator, air vent, and valved tubing;
- .7 For pump(s), in lieu of a flush line filter, factory installed valved seal flush line tubing with cyclone type separator and sight flow indicator.
- .2 Acceptable split coupled vertical in-line pumps are:
  - .1 Armstrong Fluid Products Series 4300
  - .2 Bell & Gossett Ltd. Series 80
  - .3 Taco
  - .4 Flo-FabSC
  - .5 Grundfos

#### 2.4 PUMP SUCTION AND DISCHARGE CONNECTION ACCESSORIES

- .1 Circulating pump manufacturer supplied suction guides with a cast iron body, stainless steel strainer screen, removable fine mesh start-up strainer screen and steel guide vanes, and cast iron body, angle or straight type control valve assemblies, each acting as a check valve, balancing valve, and shut-off valve. Acceptable products are:
  - .1 S. A. Armstrong Ltd. Type "SG" suction guides and "Flo-Trex" cast iron combination control valve assemblies with check valve, balancing valve, and shut-off valve
  - .2 Bell & Gossett Ltd.
  - .3 Grundfos

#### 2.5 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. Acceptable products are:
  - .1 Thorburn Equipment Inc. corrugated metal hose
  - .2 Senior Flexonics Inc. A1 and A6 Series
  - .3 The Metraflex Co.

### 3 EXECUTION

#### 3.1 INSTALLATION OF HEATING/COOLING CIRCULATING PUMPS

- .1 Provide centrifugal circulating pumps where shown on the Drawings.
- .2 Vertical Inline Pump(s): Secure vertical inline pumps in place in accordance with requirements of the Drawing detail.
- .3 Suction and Discharge Connection Accessories: Provide a shut-off valve and suction guide in pump suction piping, and a combination check-balance-shut-off valve assembly in pump discharge piping, installed in accordance with the manufacturer's instructions. Remove

- suction guide start-up strainer screens after piping, flushing and cleaning is complete. Suction and discharge connection accessories are to be minimum line size. Note that combination check-balance-shut-off valve assemblies shall be 150 mm (6") away from the pump discharge for discharge piping to 150 mm (6") diameter, and 300 mm (12") away from the pump discharge for discharge pipe larger than 150 mm (6") diameter.
- .4 For pumps equipped with seal flush line filters, replace the flush line filter cartridge when pipe flushing and cleaning is complete.
  - .5 Prior to the start-up of all pumps, ensure that:
    - .1 Pump-motor alignment is correct, and, if necessary, realign in accordance with the manufacturer's instructions;
    - .2 Pump is properly primed;
    - .3 Pump rotation is correct.
  - .6 If the circulating pumps are used for piping flushing and cleaning, and pump seal flush line filters are not installed, replace the pump mechanical seals when flushing and cleaning is complete.

**END OF SECTION 23 21 23**

1 GENERAL

1.1 SUMMARY

- .1 Supply and install all equipment and media related hydronic loop water treatment, this includes but is not limited to glycol fluid, glycol make-up package, cleaning chemicals, corrosion inhibitors and chemical pot feeders.

1.2 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM)
  - .1 ASTM A105, Standard Specification for Carbon Steel Forgings for Piping Applications.
  - .2 ASTM A743/A743A, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
  - .3 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .4 ASTM B283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed).
- .2 National Building Code 2015 (NBC)

1.3 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Provide the manufacturer's product literature and datasheets for all equipment and chemical treatments listed in this specification.
  - .2 Submit WHIMS – Materials Safety Data Sheets.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into O&M manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- .1 All equipment model numbers listed in this specification are based on products from Water Management Consultants (WMC), Ltd. Other acceptable manufacturers of water treatment equipment are as follows:
  - .1 General Filtration.
  - .2 Griswold Water Systems.
  - .3 Neptune (Dover Company).
  - .4 JL Winglet Co.
  - .5 Walchem

- .6 Axiom
- .7 Metex
- .2 Acceptable manufacturers of chemical solutions (glycol, corrosion inhibitor, biocides, etc) are as follows:
  - .1 Dow Chemical Company
  - .2 GE Water & Process Technologies
  - .3 RDI Chemical Corporation (KEM Canada Mfg/Trojan Chemicals)
  - .4 EcoLab Inc. (Nalco Water)

## 2.2 CLOSED HYDRONIC WATER SYSTEM TREATMENT EQUIPMENT

- .1 Equipment in this section shall be provided for each closed hydronic water system.
- .2 Sidestream Chemical Pot Feeders (WMC PF-5X4HP or equivalent ):
  - .1 For each closed hydronic water system, provide one (1) sidestream chemical pot feeder to allow addition of corrosion inhibitor and biocides as needed.
  - .2 Each pot feeder shall be constructed of welded carbon steel or stainless steel, complete with nitrile (Buna) or EPDM gaskets.
  - .3 Pot feeder shall be rated for a maximum temperature of 93.3°C (200°F) or greater and shall have a maximum operating pressure equal to or greater to 1380 kPa (200 psig). Inlet, outlet, drain and vent connections shall be 20 mm (¾ in.) FNPT.
  - .4 Each pot feeder shall be sized to have appropriate capacity based on the total closed system volume:
    - .1 Minimum 7.6 L (2 gal) feeder for system volumes up to and including 1,893 L (500 gal).
    - .2 Minimum 18.9 L (5 gal) feeder for system volumes between 1,893 L (500 gal) and 18,927 L (5000 gal).
    - .3 Minimum 45.4 L (12 gal) feeder for system volumes above 18,927 L (5000 gal).
- .3 Sidestream Cartridge Filter Housings (WMC GFC SERIES or equivalent ):
  - .1 For each closed hydronic water system, provide one (1) sidestream cartridge filter housing for ongoing particulate removal, sized to 2.5% to 5% of the maximum flow rate of each system.
  - .2 Each filter housing shall be constructed of welded carbon steel or stainless steel, complete with nitrile (Buna) or EPDM gaskets.
  - .3 Filter housings shall be rated for a maximum temperature of 93.3°C (200°F) or greater and shall have a maximum operating pressure equal to or greater to 1380 kPa (200 psig).
  - .4 Filter housings shall be designed to accept standard, 65mm (2.5 in.) DOE (double open-ended) string-wound or poly-wound filter cartridges. Filter housings designed for proprietary cartridges are not acceptable.
  - .5 Filter Cartridges (WMC VIPER SERIES or equivalent )
    - .1 Supply an initial quantity of 20-micron polypropylene-wound filter cartridges with tin-free steel core, rated for at least 200°F maximum water temperature.

- .2 Include sufficient quantity to allow six (6) complete change-outs per filter housing.
- .4 Corrosion Coupon Rack Assemblies (WMC CR4-075CS or equivalent ):
  - .1 For each closed hydronic water system, supply one (1) pre-assembled steel corrosion coupon rack to allow for monitoring the effectiveness of the water management program.
  - .2 Each rack shall have a minimum of four (4) stations and shall be constructed of Sch 40 black steel piping with 19mm (3/4 in.) NPT inlet/outlet connections. The assembly shall include carbon steel coupon holders with Teflon (PTFE) stems and nylon mounting hardware.
  - .3 Each corrosion coupon rack shall be rated for a maximum temperature of 93.3°C (200°F) or greater and shall have a maximum operating pressure equal to or greater to 1380 kPa (200 psig).

## 2.3 CLOSED HYDRONIC GLYCOL SYSTEM EQUIPMENT

- .1 Equipment in this section shall be provided for each closed hydronic glycol system.
- .2 Automatic Glycol Feed System:
  - .1 For each closed hydronic glycol system, supply one (1) self-contained automatic glycol feed system designed for closed loop glycol makeup applications. System shall be equivalent to Calefactio Solutions Inc. GMP Series, package type, automatic glycol solution make-up and pressure control unit. The package is to be shipped completely assembled, prewired, and complete with:
    - .1 Storage Tank: 189 L (50 gal) round translucent polyethylene storage tank with manual valve, strainer, and removable cover with cut-out for insertion of glycol solution recovery piping from the system relief valve.
    - .2 Support Stand: a welded, cleaned, primed and painted structural steel stand with support legs, centering brackets for the storage tank, and a shelf under the storage tank for mounting the pump, pressure tank and accessories
    - .3 Pump Assembly: 115 volt, 1 phase, 0.373 kW (½ HP) horizontal direct coupled pump with a make-up capacity of 7.3 L/min @ 480 kPa (1.8 GPM @ 70 psi), flexible hose suction connection from the storage tank, discharge connection with PRV and shut-off valve, a priming valve, a sealed bladder type pressure tank, 12 mm (½") copper tubing with NPT adapter for glycol solution connection to the system, and pressure gauges to indicate pressure tank and system pressures
    - .4 Controls and Safeties: Protected magnetic starter for the pump complete with Hand/Off/Auto switch, pump control pressure switch, and safeties consisting of auto reset low storage tank glycol solution cutout with audible and visual alarm, alarm reset excessive pressure cutout with audible and visual alarm, a silencing switch for audible alarms, and a contact for connection of alarms into a building management system or to a remote alarm, all located in a NEMA 1 control panel
    - .5 Acceptable manufacturers are:
      - .1 Calefactio Solutions Inc.
      - .2 Bell & Gossett (Xylem Inc.)
      - .3 GE Water & Process Technology
- .3 Sidestream Cartridge Filter Housings (WMC GFO/GFS SERIES or equivalent ):



- .1 For each closed hydronic glycol system, provide one (1) sidestream cartridge filter housing to allow ongoing particulate removal, sized for 2.5% to 5% of the maximum system flow rate. Each filter housing shall be welded carbon steel or stainless steel, rated for a maximum temperature of 200°F or greater, and shall have a maximum operating pressure equal to or greater than the specified system pressure at the location where the housing is to be installed. For low pressure systems, the minimum pressure rating for any supplied cartridge filter housing shall be 150 psi.
- .2 Filter housings shall be designed to accept standard, 2.5" DOE (double open-ended) string-wound or poly-wound filter cartridges. Filter housings designed for proprietary cartridges are not acceptable.
- .3 Filter Cartridges (WMC VIPER SERIES or equivalent ):
  - .1 Supply an initial quantity of 20-micron polypropylene-wound filter cartridges with tin-free steel core, rated for at least 200°F maximum fluid temperature. Include enough replacement cartridges for six (6) complete change-outs per filter housing.
- .4 Corrosion Coupon Rack Assemblies (WMC CR4-075CS or equivalent )
  - .1 For each closed hydronic glycol system, supply one (1) pre-assembled steel corrosion coupon rack to allow for monitoring the effectiveness of the water management program.
  - .2 Each rack shall have a minimum of four (4) stations and shall be constructed of Sch 40 black steel piping with 19mm (3/4 in.) NPT inlet/outlet connections. The assembly shall include carbon steel coupon holders with Teflon (PTFE) stems and nylon mounting hardware.
  - .3 Each corrosion coupon rack shall be rated for a maximum temperature of 93.3°C (200°F) or greater and shall have a maximum operating pressure equal to or greater to 1380 kPa (200 psig).
- .5 Inhibited Glycol Supply:
  - .1 Provide an adequate quantity of inhibited 40% propylene glycol to fill all systems to the specified concentrations as indicated on the drawings and equipment schedules.
  - .2 Glycol solution shall be specifically designed for hydronic heating and cooling applications and shall be formulated with dipotassium phosphate (DKP) based industrial inhibitor packages and buffers to prevent corrosion and prolong the life of piping and equipment.
  - .3 For closed loop chilled glycol or tempered glycol systems operating below 120°F, a buffered molybdate non-nutrient corrosion inhibited glycol or for hot water and low-oxygen systems, a buffered nitrite corrosion inhibited glycol may be used. .  
Uninhibited glycols (without separate inhibitors) and automotive-grade antifreeze products are not acceptable. Uninhibited glycols (with separate inhibitors) shall include documentation from the chemical supplier indicating correct concentrations to achieve optimal corrosion protection and pH levels.

### 3 EXECUTION

#### 3.1 INSTALLATION OF AUTOMATIC GLYCOL FEED SYSTEM

- .1 Provide one (1) glycol makeup unit for each closed loop glycol piping system as shown in the Drawings.
- .2 Pipe the system relief valve back to glycol makeup tank

- .3 After the piping system has been flushed, cleaned, and filled ensure each glycol makeup tank is half full with the glycol/water mixture.
- .4 Supply one (1) spare 200 L (59 gal) barrel of glycol for each system and turn over to the Project Co. and Owner at the site before application for a Certificate of Substantial Performance of the Work.

### 3.2 **INSTALLATION OF SIDESTREAM POT FEEDERS & CARTRIDGE FILTER HOUSINGS**

- .1 Provide pot type chemical feeders and cartridge filter housings at pump locations as shown on the Drawings.
- .2 Connect the feeder/filter house with bypass piping between pump suction and discharge piping in accordance with the feeder manufacturer's instructions.
- .3 Locate the feeder/filter so that it is easily accessible for maintenance and filling.

### 3.3 **CLOSED HYDRONIC SYSTEM PRE-OPERATIONAL FLUSHING AND CLEANING**

- .1 After new hydronic piping system has been installed and leakage testing has been verified, but before mechanical equipment start-up and performance tests, flush and chemically clean all hydronic piping systems.
- .2 Provide all 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 the chemical manufacturer/installer. Ensure that control valves are operational and fully open during flushing and cleaning.
- .3 For each closed water or glycol system, supply an adequate quantity of a neutral-pH pre-operational cleaning agent containing a blend of sequestering and dispersing agents specifically designed to clean new recirculating hydronic piping systems to remove mill scale, iron oxide, oil and grease.
- .4 The pre-operational cleaning and flushing procedure shall be carried out as per the manufacturer's or water treatment provider's instructions. Mechanical contractor to install temporary bypasses, piping, strainers, etc. as required to allow addition and circulation of the cleaning solution through system piping.
- .5 Following completion of the cleaning and flushing procedure for each closed hydronic system and before final addition of corrosion inhibitor or inhibited glycol, a report shall be generated to confirm that the cleaning and flushing procedure has been completed successfully. The report shall include testing results of a representative system sample, confirming conductivity, pH, iron and copper levels are within acceptable ranges.

### 3.4 **CLOSED WATER SYSTEM CHEMICAL TREATMENT PROGRAM**

- .1 For each closed water system, establish a chemical treatment program to include all corrosion inhibitors and microbiological control agents required to properly treat the recirculating water.
- .2 The chemical inhibitor package shall include all mild steel and copper alloy corrosion inhibitors. For closed chilled water or tempered water systems operating below 120°F, use a buffered molybdate non-nutrient corrosion inhibitor. For hot water and low-oxygen systems, use a buffered nitrite corrosion inhibitor. All products shall contain adequate tolyltriazole (TTA) for optimal yellow metal protection. Each closed water system shall be supplied with an initial dose of corrosion inhibitor to achieve a minimum concentration of 90-120 ppm molybdate (as Mo) or 900-1200 ppm nitrite (as NaNO<sub>2</sub>).

- .3 The biocide program shall be comprised of a non-oxidizing antimicrobial agent for control of bacteria, algae, fungi and slime-forming organisms, to be added to the system as required or recommended by the manufacturer.
- .4 Once stable results have been achieved, a report shall be provided to certify that water chemistry parameters are within recommended ranges.

3.5 **WATER TREATMENT TESTING CABINET**

- .1 Supply one (1) wall-mount metal storage cabinet per hydronic or glycol system, complete with a set of handheld electronic meters, test kits and associated reagents required to perform on-site water testing of conductivity, pH, hardness, alkalinity, chlorides and inhibitor level. Include a handheld refractometer for measuring glycol concentration.

**END OF SECTION 23 25 00**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers International (ASME)
  - .1 ASHRAE Standard 52.1, Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
  - .2 ASHRAE Standard 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .2 American Society for Testing and Materials International (ASTM)
  - .1 A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
  - .2 A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
  - .3 A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .4 A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
  - .5 B209/B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 HVAC Duct Construction Standards - Metal and Flexible.
  - .2 HVAC Air Duct Leakage Test Manual.
- .4 Canadian Standards Association (CSA):
  - .1 CSA/ULC S102.2, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S110, Standard Methods of Test For Air Ducts.
- .5 Underwriters' Laboratories, Inc. (UL)
  - .1 UL 181, Standard for Safety Factory-Made Air Ducts and Connectors.
- .6 National Building Code 2015 (NBC)

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
  - .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Duct Construction: Provide the manufacturer's product literature of all catalogued components to be supplied. Include manufacturer's data sheets for certification, performance criteria, ratings, and physical dimensions and finishes.
  - .3 Submit marked up prints showing detailed locations of all devices mounted in or on ductwork, dimensioning their locations.
- .3 Shop Drawings: Submit shop drawings for the following:
  - .1 Duct construction

- .2 Manual balancing dampers
- .3 Backdraft dampers
- .4 Fusible link dampers
- .5 Combination fire/smoke dampers
- .6 Roof duct supports
- .7 Explosion/implosion access doors
- .8 Acoustic panels
- .9 Grilles and diffusers
- .10 Silencers
- .11 Louvres
- .12 Brick and/or block vents
- .13 Roof mounted intake/exhaust hoods
- .14 VAV boxes
- .15 Constant volume boxes
- .16 Motorized control dampers and thermostats
- .17 Flue(s)
- .4 Test Data:
  - .1 Submit duct leakage test data prior to ductwork being covered from view.
- .5 Colour Chart(s): Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.
- .6 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

### 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan (WMP).
- .4 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 DUCTWORK

- .1 General: All ductwork shall be designed, constructed, supported and sealed in accordance with SMACNA HVAC Duct Construction Standards and pressure classifications, unless otherwise noted. When the ductwork pressure classification of these standards is exceeded, construct ductwork in accordance with SMACNA Round and Rectangular Industrial Duct Construction Standards.
- .2 Galvanized Steel - Rectangular: Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, with metal gauges in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible (minimum 0.478 mm - 26 ga) to suit the duct configuration, a

duct pressure class designation (positive and negative as applicable) as described in Part 3 - Execution. The steel thickness and zinc coating class shall be factory stencilled on the steel. Galvanizing for concealed ductwork and exposed ductwork to be finish painted shall be G60. Exposed unpainted ductwork shall be G90.

- .3 Galvanized Steel - Round: Helically wound "RL-1" flat-lock seam construction conforming to ASTM Standards A653 or A924, shop or factory fabricated, water-tight, with metal gauges and fabrication in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Construction shall suit the duct configuration and a duct pressure class designation (positive and negative) as described in Part 3 Execution. Standard elbows shall have 1.5 centerline radius, other radii and vanded elbows shall be available as needed. Elbows through 300 mm (12 in.) shall be die formed, with stitch welded joints. Elbows 350 mm (14 in.) through 750 mm (30 in.) shall be gore-locked construction. All elbows above 800 mm (32 in.) shall also be gored, but with tack weld and sealed construction for use to 4" w.g., or solid welded for use to 10" w.g. Branch connections shall be conical for 90 degree taps, and straight for 45 degrees. Seams and tap connections shall be tack welded and sealed with mastic for use up to 4" w.g., or solid welded for use to 10" w.g. Standard connections are slip fit with couplings, gasketed, or flanged. Galvanizing for concealed ductwork and exposed ductwork to be finish painted shall be G60. Exposed unpainted ductwork shall be G90.
- .4 Galvanized Steel - Round – Pre-insulated: Lindab Inc. D/W "LINDAB ISOL" helically wound and mechanically locked spiral duct conforming to ASTM Standards A653 and A924 in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible to 2.5kPa (10" w.g.) pressure. Solid galvanized liner wrapped in 1" fiberglass insulation with a maximum conductivity factor (k) of 0.26 BTU-in/hr x °F t 75°F mean ambient temperature. Core assembly shall be sleeved by a galvanized solid outer pressure shell. "LINDAB ISOL" fittings and couplings shall be minimum G60 and equipped with factory installed double-lipped U-profile EPDM rubber gasket permanently fastened by means of a stainless steel band. Duct and fittings include closed-cell elastomeric foam insulation stops and the system must be calibrated to meet SMACNA's Leakage Class 3 integrity. The EPDM gasket shall be classified by Underwriters Laboratories (ULC) for flame spread less than 25 and smoke developed ratings less than 50 in accordance with CSA/ULC S102.2.
- .5 Gauges must meet or exceed the requirements listed in Table 1 below:

Diameter	Spiral Duct	Fittings
75 mm – 350 mm (3 inches – 14 inches)	0.533 mm (26 gge)	0.686 mm (24 gge)
400 mm – 650 mm (16 inches – 26 inches)	0.686 mm (24 gge)	0.838 mm (22 gge)
700 mm – 900 mm (28 inches – 36 inches)	0.838 mm (22 gge)	0.991 mm (20 gge)
950 mm – 1250 mm (38 inches – 50 inches)	0.991 mm (20 gge)	0.991 mm (20 gge)

- .1 Acceptable manufacturers are:
  - .1 Lindab Inc. (Peppertree Air Solutions Inc.)
  - .2 Stamped Fittings Inc. Gasketed Product: The EDGE
- .6 Aluminum - Rectangular: Construction conforming to ASTM Standard B209, (Alloy 3003 Temper H14 aluminum), shop or factory fabricated, water-tight, with metal gauges and fabrication in accordance with SMACNA Rectangular HVAC Duct Construction Standards Metal and Flexible to suit the duct configuration, a duct pressure class designation (positive and negative as applicable) as described in Part 3 Execution, and Type 304 stainless steel support hardware.

- .7 Aluminum - Round: Helically wound "RL-1" flat-lock seam construction conforming to ASTM Standard B209 (Alloy 3003-H14 aluminum), shop or factory fabricated, water-tight, with metal gauges and fabrication in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Construction shall suit the duct configuration and a duct pressure class designation (positive and negative) as described in Part 3 Execution. Standard elbows shall have 1.5 centerline radius (other radii and vaned elbows shall be available as needed) with stainless steel rivets and silicone sealant. Fitting joints and connections shall be either slip fit, gasketed or flanged. Use aluminum fasteners/ support hardware.
- .8 Stainless Steel – Rectangular: Construction conforming to ASTM Standard A240 or A480 (Type 304), with a #4 finish where bare (uncovered) and exposed in finished areas and a No. 2B finish elsewhere. Unless otherwise specified metal gauges and fabrication in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Shop or factory fabricated, water-tight, to suit the duct configuration and a duct pressure class designation (positive and negative) as described in Part 3 Execution, stainless steel support hardware to match the duct material.
- .9 Stainless Steel – Round: Helically wound "RL-1" flat-lock seam construction conforming to ASTM Standard A240 or A480 (Type 304 or 316) stainless steel, shop or factory fabricated, water-tight, with metal gauges and fabrication in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Construction shall suit the duct configuration and a duct pressure class designation (positive and negative) as described in Part 3 Execution. Elbows through 300 mm (12 in.) shall be die formed, with stitch welded joints. Elbows 350 mm (14 in.) through 750 mm (30 in.) shall be gore-locked construction. All elbows above 800 mm (32 in.) shall also be gored, but with tack weld and sealed construction for use to 4" w.g., or solid welded for use to 10" w.g. Branch connections shall be conical for 90 degree taps, and straight for 45 degrees. Seams and tap connections shall be tack welded and sealed with mastic for use up to 4" w.g., or solid welded for use to 10" w.g. Standard connections are slip fit with couplings, gasketed, or flanged.
- .10 Flexible Metallic - Uninsulated: SMACNA form "M-UN" spirally wound, corrugated and mechanically locked 3003 aluminum strip forming a continuous airtight tri-lock seam, tested for air velocities up to 20.3 m/s (4000 FPM) and operating pressures from 1.5kPa (6" w.g.) positive to 0.25kPa (1" w.g.) negative. ULC-S110 Listed Class 1 Air Duct Connector with a flame spread and smoke developed rating of less than 25/50.
  - .1 Acceptable manufacturers are:
    - .1 Peppertree Air Solutions Inc., Type TF
    - .2 Westaflex Inc.
- .11 Flexible Metallic - Insulated: SMACNA form "NM-IL". Acoustic rated, core shall be constructed of spirally wound strip of chlorinated polyethylene, interlocked with external helix, factory wrapped in Owens Corning Greenguard Certified R4.2 insulation with installed wall thickness of not less than 1.125" and sleeved by a flame retardant metalized vapour barrier. Approved for air velocities up to 20.3 m/s (4000 FPM) and operating pressures from 1.5kPa (6" w.g.) positive to 0.25kPa (1" w.g.) negative. ULC-S110 Listed Class 1 Air Duct Connector with a flame spread and smoke developed rating of less than 25/50.
  - .1 Acceptable manufacturers are:
    - .1 Peppertree Air Solutions Inc., Type HM
    - .2 Westaflex Inc.
- .12 Fiberglass Reinforced Plastic (FRP) – Rectangular and Round: Factory fabricated duct and fittings in accordance with CAN/CGSB 41.22 and the SMACNA manual entitled "THERMOSET FRP DUCT CONSTRUCTION MANUAL", pigment coloured as selected from the manufacturer's standard colours, with thixotropic resin paste sealed and fibreglass cloth and resin overwrapped bell and spigot joints for round ducts, air-tight gasketed flanged joints

with type 316 stainless steel bolts, lock washers and nuts for rectangular ducts and type 316 stainless steel support hardware outdoors or non-metallic support systems indoors.

- .1 Underground ductwork to be installed beneath truck traffic. The duct shall be capable of handling a minimum loading pressure of 25kPa from a 70kN wheel load (estimated based on design installation depth) in excess of the slab weight and fill overburden (estimated to be 24kPa based on design installation depth). Final pressure load shall be provided to manufacturer according to final installation depth.
- .2 Acceptable manufacturers are:
  - .1 M.K. Plastics Corp.
  - .2 Plasticair Inc.
  - .3 Industrial Plastic Fabricators Ltd.
  - .4 Monoxivent Inc.
  - .5 Precisioneering Ltd
- .13 Plastic – Round: Extruded PVC manufactured from Type 1 resins in accordance with ASTM D-1784 and requirements of the SMACNA "THERMOPLASTIC DUCT (PVC) CONSTRUCTION MANUAL", and complete with type 316 stainless steel support hardware outdoors or non-metallic support systems indoors.
- .14 High-Density Polyethylene (HDPE) Underground Duct System
  - .1 Complete duct system (including inlet plenums, round duct, run-outs, diffuser boots, etc.) must be from one manufacturer and be of the same material, construction and connection method throughout. Field made duct components are NOT acceptable.
  - .2 Provide elbows, ducts, diffuser boxes, plenums, clamp & gaskets, boots, saddle registers and caulk as required by drawings for underground installation.
  - .3 Unless otherwise noted, all duct and fittings shall be constructed per SMACNA's Duct Construction Standards to withstand +10" w.g. and -2" w.g.
  - .4 Ductwork shall be closed cell plastic material that is recyclable, does not emit volatile organic compounds, and conforms to ASTM-D2412. Ductwork shall be resistant to mildew, mold (UL 181B), and radon gas (BSS 7239-88). Ductwork shall not rust or crack under external stress or strain.
  - .5 Underground ductwork to be installed under truck traffic. The duct shall be capable of handling a minimum loading pressure of 25kPa from a 70kN wheel load (estimated based on design installation depth). Final pressure load shall be provided to manufacturer according to final installation depth.
  - .6 Ductwork shall have integral R-10 equivalent thermal insulation value, without the use of external insulation, per NSF's P374 Protocol and verified by a NSF Thermal Testing Report.
  - .7 All joints shall be sealed via gasket or bolts and sealant.
  - .8 Clamps and gaskets shall be used on ductwork without flanges. Clamps shall be polyethylene with stainless steel plates and stainless-steel screws. Gaskets shall comprise of ¼" thick butyl rubber sealant tape that is water and UV resistant and shall not stain. Gaskets shall comply with ASTM-E84 for flame and smoke spread.
  - .9 Flanged joints and duct branches shall use a co-polymer adhesive caulking sealant that is water and UV resistant. Flanges shall be connected with stainless steel bolts.
  - .10 Assembled ductwork shall be able to maintain pressure with no leakage.
  - .11 Duct system shall be installed by an AQC Industries' trained installer.



- .12 Slope ductwork as indicated on drawings and provide minimum 50mm condensate drainage connection.
- .13 Duct system performance shall exceed SMACNA's Leakage Class 1 requirements at the system design static pressure.
- .14 Duct system shall carry a 10-year Limited Warranty.
- .15 Provide structural tie downs and anti-floating ballast.
- .16 Acceptable manufacturers are:
  - .1 Blue Duct (AQC)
  - .2 Approved equivalent
- .15 Flexible Metallic – Uninsulated: SMACNA Form "M-UN" spirally wound, corrugated and mechanically locked 3003 aluminum strip forming a continuous airtight tri-lock seam, tested for air velocities up to 27.94 m/s (5500 FPM) and operating pressures from 3 kPa (12 inch WG) positive to 2.49kPa (10 inch WG) negative. UL-181 Listed Class 0 Air Duct with Flame Spread and Smoke Developed Rating of "0" and listed in conformance to NFPA Standards 90A and 90B.
  - .1 Acceptable manufacturers are:
    - .1 Peppertree Air Solutions Inc. (Type TF)
    - .2 Westaflex Inc. Phone No. (858) 549-0909

## 2.2 NON METALLIC DUCT SUPPORT SYSTEM

- .1 FRP channel shall be of the pultruded glass-reinforced polyester or vinyl ester resin. Glass-reinforced channel shall have a synthetic surfacing veil applied on the exterior surfaces to improve weatherability and inhibit ultraviolet degradation. An ultraviolet stabilizer shall be incorporated in the resin formulation to further inhibit ultraviolet degradation.
- .2 Glass-reinforced channels shall have a flame/smoke rating of 25/50 or less.
- .3 Non metallic fasteners shall be manufactured from long glass fibre reinforced polyurethane to ensure maximum strength and corrosion resistance.
- .4 All components shall be non metallic except where type 316 stainless steel hardware is used as part of the assembly.
- .5 Include for all necessary components such as rods, fasteners splice plates, brackets, sealants, hangers, struts, clevis pipe hangers, pipe clamps etc
  - .1 Acceptable manufacturers are:
    - .1 Unistrut
    - .2 B-Line
    - .3 StrutTech

## 2.3 CASING AND PLENUM MATERIAL

- .1 Unless otherwise specified in the Contract Documents, casing and plenum material shall be the same as the connecting duct material. If connecting duct is galvanized steel the galvanizing shall be G90.
- .2 Unless otherwise specified in the Contract Documents, each plenum shall have a hinged access door and each intake plenum shall have a watertight drainage pan and 25mm drainage port.

- .3 Unless otherwise specified in the Contract Documents, each intake or exhaust penthouse shall have a watertight intake/ exhaust plenum c/w a hinged access door and watertight drainage pan and 25mm drainage port.
- .4 Casing and plenums shall be thermally insulated.

## 2.4 DUCT SYSTEM JOINT SEALANT

- .1 Ductmate "PROseal" High Velocity Duct Sealant or approved equivalent ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush or gun applied, with a maximum flame spread rating of 0 and smoke developed rating of 0.

## 2.5 ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Peppertree Air Solutions Inc. "SPIN-ON" or approved equivalent G60 or G90 galvanized steel, flared notched and beaded round duct take-off collar complete with damper and associated hardware (including spring loaded damper clip, threaded damper clip, locking wing-nut and aluminum handle) to be installed in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible
  - .1 Acceptable manufacturers are:
    - .1 Peppertree Air Solutions Inc.
    - .2 Westaflex Inc.

## 3 EXECUTION

### 3.1 FABRICATION OF DUCTWORK

- .1 Unless otherwise specified in the Contract Documents, construct, install and seal ductwork in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct pressure class designations positive and negative as listed below. Construct ductwork so the manufacturer's gauge markings are external. Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting ductwork. Unless otherwise shown or specified, hang or support ductwork from the structure only. Where the ductwork is insulated, supports and hangers shall be of sufficient length to allow the insulation and covering to pass between the hangers unbroken.
- .2 The following low pressure and medium pressure construction is based on the SMACNA method of construction, and gives a minimum standard of construction. Proposed alternatives are acceptable provided they follow the SMACNA HVAC Duct Construction Standards. Submit alternatives for review prior to fabrication.
- .3 Low Pressure Rectangular Ducts: For systems less than 0.5 kPa (2" w.g.) static pressure and under 10.2 m/s (2000 fpm) velocity. Construct low pressure rectangular ducts as follows in Table 2:
  - .1 Bracing spacing shown is maximum spacing between two bracings or between bracing and joint.
  - .2 Locate bracings mid-way between joints.
  - .3 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.

Table 2: Low Pressure Rectangular Duct Construction

Max. Duct Dimension	Sheet Metal (ga)	Transverse Joint Connection and Bracing
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Up to 300 mm (12 in.)	26	Flat drive or flat 'S' no bracing
325 mm to 425 mm (13 in. to 18 in.)	24	Flat drive or flat 'S' no bracing
475 mm to 750 mm (19 in. to 30 in.)	24	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
775 mm to 1050 mm (31 in. to 42 in.)	22	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1075 mm to 1200 mm (43 in. to 48 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1225 mm to 1350 mm (49 in. to 54 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1375 mm to 1500 mm (55 in. to 60 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1525 mm to 2100 mm (61 in. to 84 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
2125 mm to 2400 mm (85 in. to 96 in.)	18	50 mm (2 in.) standing 'T' bracing 38 mm x 38 mm x 5 mm (1-1/2 in. x 1-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm to 3000 mm (97 in. to 120 in.)	18	50 mm (2 in.) standing 'T' bracing 50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) at maximum 600 mm (24 in.) centres.
3025 mm and over (121 in. and over)	18	As above with addition of tie rods at 300 mm (120 in.) centres for joint bracing.

- .4 Medium Pressure Rectangular Ducts: For systems above 0.5 kPa (2" w.g.) static pressure and below 1.5 kPa (6" w.g.) static pressure, and above 10.2 m/s (2000 fpm) velocity. Construct medium pressure rectangular ducts as follows in Table 3:

- .1 Bracing spacing shown above is maximum spacing between two bracings or between bracing and joint. Locate bracing mid-way between joints.
- .2 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.

Table 3: Medium Pressure Rectangular Duct Construction

Max. Duct Dimension	Sheet Metal (ga)	Transverse Joint Connection and Bracing
Up to 300 mm (12 in.)	24	25 mm (1 in.) standing seam, 16 mm (5/8 in.) welded flange 25 mm (1 in.) pocket lock, no bracing.
325 mm to 425 mm (13 in. to 18 in.)	24	25 mm (1 in.) standing seam, 22 mm (7/8 in.) welded flange, 25 mm (1 in.) pocket lock, bracing 25 mm x 25 mm x 16 gauge (1 in. x 1 in. x 16 UG gauge) at 1200 mm (48 in.) centres.
475 mm to 600 mm (19 in. to 24 in.)	22	32 mm (1-1/4 in.) standing seam, 35 mm (1-3/8 in.) welded flange, 30 mm (1-1/8 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
625 mm to 900 mm (25 in. to 36 in.)	22	38 mm (1-1/2 in.) standing seam, 38 mm (1/2 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
925 mm to 1200 mm (37 in. to 48 in.)	22	50 mm (2 in.) standing seam or 50 mm (2 in.) flanged joint, bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 750 mm (30 in.) centres.
1125 mm to 1500 mm (49 in. to 60 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1525 mm to 1800 mm (61 in. to 72 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1825 mm to 2100 mm (73 in. to 84 in.)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm and over (96 in. and over)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.

- .5 Low and medium pressure round ducts: For systems below 1.5 kPa (6 in.) static pressure. Use products specified in Part 2 - Products wherever possible, otherwise construct low and medium pressure ducts as follows:

- .1 Round ducts up to 750 mm (30 in.) dia. shall be factory fabricated, helically wound galvanized iron strips with spiral lock seam as follows. Join with galvanized iron coupling sleeves or conduit fittings of welded construction:

Table 4: Low and Medium Pressure Round Duct Construction (Up to 750mm)

Diameter	Strip Metal (ga)	Strip Joint	Girth Joint
Up to 200 mm (8 in.)	26	100 mm (4 in.)	50 mm (2 in.) long slip
225 mm to 550 mm (9 in. to 22 in.)	24	100 mm (4 in.)	50 mm (2 in.) long slip
575 mm to 750 mm (23 in. to 30 in.)	22	150 mm (6 in.)	100 mm (4 in.) long slip

- .6 Construct larger ductwork as follows with longitudinal lock or butt welded seams:

Table 5: Low and Medium Pressure Round Duct Construction (Up to 900mm)

Diameter	Strip Metal (ga)	Reinforcing	Girth Joint
775 mm to 900 mm (31 in. to 36 in.)	20	None	100 mm (4 in.) long slip
925 mm to 1500 mm (37 in. to 60 in.)	18	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle on max 1800 mm (72 in.) centres	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle flanged.
775 mm to 900 mm (31 in. to 36 in.)	20	None	100 mm (4 in.) long slip

- .7 All ductwork shall be sealed in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings.

### 3.2 GENERAL INSTALLATION OF DUCTWORK

- .1 Galvanized Steel - Low pressure: Install low pressure galvanized steel ductwork in the following areas noted below, unless the system static pressure exceeds the Low pressure classification:
- .1 For all standalone fancoil unit ductwork.
  - .2 For all exhaust air ductwork (except those noted to be aluminum).
  - .3 For all supply air ductwork downstream of VAV terminals.
- .2 Galvanized Steel – Medium Pressure: Install medium pressure galvanized steel ductwork in the following areas noted below, unless the system static pressure exceeds the Medium pressure classification.
- .1 For all supply air ductwork between the air handler supply fan and air terminals
  - .2 For all return air ductwork.

- .3 Galvanized Steel – High Pressure: Install high pressure galvanized steel ductwork according to system static pressure.
  - .1 Refer to mechanical schedules.
- .4 Aluminium – Low Pressure: Install low pressure aluminium ductwork in the following areas noted below.
  - .1 Exhaust air ductwork on its entirety from the exhaust grille/ diffuser and all the way to exhaust to outdoors, that contains moisture laden air, such as exhaust air from lockers with shower area, shower area, washroom with shower area, or similar spaces.
  - .2 Ductwork shall be watertight construction and shall be sloped towards the exhaust grille/ diffuser throughout, as feasible.
- .5 Stainless Steel – Low Pressure: Install low pressure stainless steel ductwork as an alternative to low pressure aluminium ductwork.
- .6 Truck wash bay – G90 Galvanized.
- .7 Underground – FRP or HDPE Duct System.
- .8 Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.
- .9 Brace and stiffen all ducts, and make tight so that they will not breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 300 mm (12 in.) or larger.
- .10 Where rectangular ducts are shown, round ducts may be substituted at the Contractor's option, provided there is sufficient room. Conversion from rectangular to round duct, sizing shall be as shown on charts in ASHRAE.
- .11 Where the reinforcing of ductwork is required use of tie rods is the preferable method.
- .12 For insulated ductwork, size the hanger support to suit the insulated duct and install the hanger or support on the outside of the insulation and covering.
- .13 Automatic Control Components: Install all duct system mounted automatic control components supplied as part of the control work specified in Section 20 05 00 – General Mechanical Requirements.
- .14 Heat Transfer Equipment Connections: Where indicated on the Drawing(s), provide duct connections to fan powered heat transfer equipment with integral coils, supplied as part of the work specified in Sections 23 82 19 – Fan Coil Units and 23 72 00 – Hydronic Air Handling Units.
- .15 Separate Duct Coils: Flange out ductwork and connect to duct heating coils in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible. The coils will be suspended independent of connecting ductwork as part of the heat transfer work specified in Section 23 82 16 – Air Duct Coils.
- .16 Rectangular Duct Support Inside Building: Coordinate with discipline responsible for Section 20 05 29 - Hangers and Supports to support horizontal rectangular ducts inside the building in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with galvanized steel channels and galvanized steel hanger rods for all ducts that are exposed, and all concealed ducts wider than 500 mm (20").
- .17 Round and Flat Oval Duct Support Inside Building: Coordinate with discipline responsible for Section 20 05 29 - Hangers and Supports to support round and flat oval ducts inside the building in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible. Unless otherwise specified in the Contract Documents, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at the top of the duct to a hanger rod,

- all similar to Ductmate Canada Ltd. type "BA". If the duct is insulated, size the strap to suit the diameter of the insulated duct.
- .18 Watertight Ductwork: Where watertight horizontal ductwork is required inside the building, construct the ducts without bottom longitudinal seams. Solder or weld the joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide the drain points. Provide watertight ductwork for:
- .1 Fresh air intakes;
  - .2 Intake and exhaust penthouse;
  - .3 A minimum of 3 m (10') upstream and downstream of duct mounted humidifiers or humidifier manifolds;
  - .4 Exhaust air ductwork on its entirety from the exhaust grille/ diffuser and all the way to exhaust to outdoors, that contains moisture laden air, such as exhaust air from lockers with shower area, shower area, washroom with shower area, or similar spaces
  - .5 Wherever else shown on the Drawings.
- .19 Application of Sealants: 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 the sealant. For Seal Class A apply the sealant on the interior of the duct.

### 3.3 DUCT LEAKAGE TESTING

- .1 Air leakage testing shall be performed in accordance with the ANSI/SMACNA HVAC Air Duct Leakage Test Manual Second Edition – 2012 and shall be witnessed by the Consultant.
- .2 Seal ducts at all equipment connections and pressurize with a small blower.
- .3 Acceptable Leakage shall be calculated based on the following criteria:
  - .1 Rectangular metal ductwork - Leakage Class 6 (cfm/100ft<sup>2</sup> @ 1" w.g.)
  - .2 Round metal ductwork - Leakage Class 3 (cfm/100ft<sup>2</sup> @ 1" w.g.)
  - .3 No less than 25% of all ductwork shall be tested at the rated static pressure of the supply or exhaust duct. If the test result is "pass" then no additional testing shall be required. If the test result is "fail" then additional leak testing shall be performed on 50% of all ductwork. If the test result is "pass" then no additional testing shall be required. If the second test result is "fail" then all 100% of ductwork shall be tested.
  - .4 All ductwork shall be tested prior to the installation of dampers, grilles, registers, coils, openings, etc that could cause a failure in the pressure test. Sections of ductwork shall be completely replaced where this occurs prior to the passing of the leakage testing.
  - .5 Positive pressure leakage testing is acceptable for negative pressure ductwork.
  - .6 Leakage factor to be calculated based on surface area of metal contained within the section and the specified test pressure using ANSI/SMACNA HVAC Air Duct Leakage Test Manual Second Edition – 2012 Fig's 5-1 & 5-1L.
  - .7 To be certified by the same testing, adjusting, and balancing agency approved by the Consultant to undertake testing, adjusting, and balancing on this project.
- .4 The system shall be tested for noise, tightness of joints and proper functioning of the system. Noise tests shall be made under minimum system pressure drop conditions (highest air velocities and clean filter conditions). This Section shall make all necessary alterations and repeat the tests until satisfactory operation is achieved.

### 3.4 INSTALLATION OF ALUMINUM DUCTWORK

- .1 Wherever bare aluminum ductwork comes in contact with ferrous metal or copper, paint the ferrous metal or copper surface with a heavy, 100% covering coat of zinc chromate paint, asphalt paint or otherwise isolate direct contact with the bare aluminum.
- .2 Slope branch aluminum ductwork down to mains and/or the riser wherever possible. Provide a drain point in the bottom of the riser, and at all other low points. Where it is not possible to slope aluminum branch ductwork down to mains or risers, slope the ductwork down to exhaust grilles.
- .3 Refer to "Commentary on Aluminium Ducts" of SMACNA HVAC Duct Construction Standards Metal and Flexible, however, do not use drive and S cleats for joining waterproof aluminum ductwork. Use the following SMACNA joining methods:
  - .1 T-21 - welded flange
  - .2 T-22 - companion angle and gasket
  - .3 T-24A flanged
- .4 Keep longitudinal joints at the top surface of horizontal runs. Provide proper transverse supports to prevent deflection. Ensure that the duct is rigid.
- .5 When mastic is used for sealing such as sealing longitudinal joints, apply the mastic to both surfaces before they are mated. When dry, apply mastic again for a water-tight seal.

### 3.5 INSTALLATION OF FLEXIBLE DUCTWORK

- .1 Provide maximum 1.5 m (5') long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers.
- .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 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.

### 3.6 INSTALLATION OF CASINGS AND PLENUMS

- .1 Provide all required casings and plenums. Construct casings and plenums of the same material as the connecting duct system, unless otherwise specified.
- .2 Construct and install casings and plenums in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the systems' pressure classification. Ensure that plenums and casings secured to the building structure are gasketed air-tight and equipped with angle reinforcing.

### 3.7 INSTALLATION OF FIBREGLASS REINFORCED PLASTIC (FRP) DUCTWORK:

- .1 Provide rectangular fibreglass reinforced plastic ductwork for underground ductwork.
- .2 Generally, install the duct in accordance with the duct manufacturer's published instructions and the requirements of the SMACNA manual entitled "THERMOSET FRP DUCT CONSTRUCTION MANUAL".
- .3 Secure the duct in place with non-metalic angles, straps, hanger rods, and accessories. Provide strips of felt or neoprene material between the duct and the hanging and support hardware.

### 3.8 INSTALLATION OF UNDERGROUND DUCTWORK:



- .1 Follow manufacturer installation instructions. Complete (mandatory) installation training provided by manufacturer prior to installation.
- .2 Excavate a trench evenly as per manufacturer installation instructions. No bedding is required except for cases of bedrock or clay where sand or light aggregate may be used.
- .3 Tie down to structure, ballast...etc.
- .4 Backfill material must consist of pea gravel or dry silica sand.
- .5 The sealant and gasket material provided by manufacturer must be used as directed. The use of non-approved sealant or gasket will void warranty
- .6 Testing
  - .1 The complete underground duct system shall be tested for leakage after final assembly.
  - .2 Follow SMACNA air duct leakage test standard.
  - .3 Allow 24 hours for sealant to cure after final assembly before testing the duct system. Additional curing time may be required in high ambient conditions follow manufacturer installation instructions.

3.9 **TESTING OF CUSTOM AIR HANDLING UNITS**

- .1 Provide support for air handling unit testing as required in Specification Section 23 72 00 – Hydronic Air Handling Units. Provide sheet metal blank off plates as required to facilitate the testing.

**END OF SECTION 23 30 00.**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 Air Movement and Control Association International, Inc. (AMCA).
  - .1 AMCA Standard 511 Certified Ratings Program Product Rating Manual for Air Control Devices.
- .2 American Society of Heating, Refrigeration, and Air Conditioning (ASHRAE)
  - .1 ASHRAE Standard 52.1-1992 Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particle Matter.
  - .2 ASHRAE Standard 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI Approved).
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- .4 Standards Council of Canada
  - .1 CAN 4-S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S112 Standard Method of Fire Test of Fire-Damper Assemblies.
  - .3 CAN/CSA-E60730-1:02, Automatic Electrical Controls for Household and Similar Use - Part 1: General Requirements
- .5 National Fire Protection Association (NFPA)
  - .1 NFPA 80 Standard for Fire Doors and other Opening Protectives.
  - .2 NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .3 NFPA 90 Standard for Air Conditioning.
  - .4 NFPA 105 Standard for Smoke Door Assemblies and Other Opening Protectives.
  - .5 NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials.
- .6 SMACNA
  - .1 SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .7 Underwriter Laboratories (UL)
  - .1 UL No. 723 Standard for Test for Surface Burning Characteristics of Building Materials.

1.2 SUBMITTALS

- .1 Shop Drawings:
  - .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
  - .2 Submit shop drawings for all equipment in this Section.
- .2 Test Data:
  - .1 Submit duct leakage test data prior to ductwork being covered from view.

### 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan (WMP).
- .4 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 SPLITTER DAMPERS

- .1 Minimum 0.95 mm thick (20 ga) damper blade constructed of the same material as the duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware DynAir Inc. #Q-50 "DYN-A-QUAP Single Shear" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin or approved equivalent.

### 2.2 AIR TURNING VANES

- .1 For square elbows – Ductmate "PROrail" multiple-radius turning vanes, interconnected with bars, adequately reinforced to suit the pressure and velocity of the system, constructed of the same material as the duct they are associated with, and in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 For short branch ducts at grille and diffuser connections - air extractor type, each equipped with a matching bottom operated 90 degree opposed blade volume control damper, constructed of the same material as the duct it is associated with, and in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.

### 2.3 MANUAL BALANCING (VOLUME) DAMPERS

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of the same material as the connecting ductwork unless otherwise specified in the Contract Documents (where aluminum is not available use stainless steel), each designed to maintain the internal free area of the connecting duct, and each complete with:
  - .1 A round shaft extension through the frame;
  - .2 Non-stick, non-corrosive bronze bearings for rectangular dampers, flange, non-stick, non-corrosive oilite bronze bearings for round dampers;
  - .3 No blade stops;
  - .4 Linkage for multiple blade dampers;
  - .5 Nailor # HL2 locking hand quadrant damper operator with 50 mm (2") standoff mounting.
- .2 Rectangular Dampers: Nailor Model #1810FDB-(GLV or SS)-DSB-BO-HLF, Spinnaker Industries Inc Model SK-1810-FF-16-CL-CB or Ruskin Model CD80VG1 (GLV or SS), maximum size 1.2m x 1.2m (4' x 4') for a single damper, and equipped with a 1.613 mm thick (16 ga) flanged type frame with 40 mm (1½") bolt hole centres, non-stick, non-corrosive bronze bearings, no sill and linkage out of air stream.
- .3 Round Dampers: Nailor Model #1090 BO FMS, galvanized or stainless steel, non-stick, non-corrosive oilite bronze bearings, full perimeter blade stop, maximum 1.2 m (4') 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 the same material as the damper and designed for tight and secure mounting of the individual dampers.

.5 Acceptable manufacturers are:

- .1 Nailor Industries Inc.
- .2 Greenheck Fan Corporation
- .3 E.H. Price Ltd.
- .4 Ruskin Company
- .5 Ventex/Alumavent

## 2.4 BACKDRAFT DAMPERS

.1 T.A. Morrison & Co. Inc. "TAMCO" Series 7000 counterbalanced backdraft dampers, 65 mm (2 1/2") deep, sized as shown on the Drawings and complete with:

- .1 Extruded aluminum frame and blades, minimum 1.52 mm (0.062") thick, with captive extruded Silicone blade gaskets and side seals in slots integral with the aluminum extrusions;
- .2 Each blade is manufactured with a mounting hole to receive a front-mounted mechanical weight supplied with the unit;
- .3 Linkage system consists of hard alloy aluminum (6005T5) crankarms fastened to zinc-plated steel pivot rods and doubly secured within channel running along top of blade. Large diameter 8.73 mm (11/32") hard alloy aluminum (6065T5) linkage rod connects the crankarms by means of a zinc-plated steel trunnion;
- .4 Air leakage through a 610 mm x 610 mm (24" x 24") weighted backdraft damper does not exceed 101.2 l/s/m<sup>2</sup> (20 cfm/ft.<sup>2</sup>) against 0.25 kPa (1" w.g.) differential static pressure at standard air.

.2 Acceptable manufacturers are:

- .1 T.A. Morrison & Co. Inc
- .2 Nailor Industries Inc.
- .3 Greenheck Fan Corporation
- .4 E.H. Price Ltd.
- .5 Ruskin Company
- .6 Ventex/Alumavent

## 2.5 CONTROL DAMPERS

.1 Control dampers shall be provided by Division 25. Contractor shall coordinate and install the dampers provided by Division 25.

## 2.6 FUSIBLE LINK (FIRE) DAMPERS

.1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified in the Contract Documents) fusible link dampers, ULC classified to Standard CAN/ULC-S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1.5 hour or 3 hour rated as required by the Contract Documents, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, an integral steel sleeve c/w retaining angles, and, unless otherwise specified in the Contract Documents, a 74°C (165°F) rated standard fusible link.

.2 Fusible link dynamic types shall consist of the following:

- .1 Dynamic curtain type shall not exceed a single section as follows:
  - .1 Horizontal mount Type "A": 610 mm wide x 610 mm high (24" wide x 24" high) Nailor Model D0114 c/w factory sleeve.
  - .2 Vertical mount Type "A": 914 mm wide x 914 mm high (36" wide x 36" high) Nailor Model D0114 c/w factory sleeve.
  - .3 Horizontal Type "B": 533 mm wide x 610 mm high (24" wide x 21" high) Nailor Model D0124 c/w factory sleeve
  - .4 Horizontal Type "B": 914 mm wide x 813 mm high (36" wide x 32" high) Nailor Model D0124 c/w factory sleeve.
  - .5 Type "A" dampers with folded blades in the airstream are only acceptable with the prior approval of the consultant
- .2 Dynamic airfoil multi-blade for sizes above 600 mm wide x 533 mm high (24" wide x 21" high):
  - .1 Vertical mount Type "A" shall not exceed 1829 mm wide x 1219 mm high (72" wide x 48" high) or 914 mm high x 2438 mm wide (36" wide x 96" high) maximum consisting of two sections. Nailor Industries Inc. Model D1201 c/w factory sleeve
  - .2 Horizontal mount Type "A" not to exceed 1626 mm wide x 1219 mm high (64" wide x 48" high) or 813 mm wide x 2438 mm high (32" wide x 96" high) maximum consisting of two sections. Nailor Industries Inc. Model D1201 c/w factory sleeve.
  - .3 Dampers with duct heights less than 203 mm (8") require Type B Nailor Industries Inc. Model D1202 c/w factory sleeve or Type "C".
  - .4 Type "A" dampers with folded blades in the airstream are only acceptable with the prior approval of the consultant
- .3 Fusible link dampers in ductwork other than galvanized steel shall be as specified above but constructed of type 316 stainless steel. Nailor Model D1201SS c/w factory sleeve:
  - .1 Type "A" single section minimum 203 mm wide x 203 mm high (8" wide x 8" high) or 914 mm high x 1219 mm wide (36" x 48") maximum single section. Vertical mount only. Nailor Model D1201SS c/w factory sleeve.
  - .2 Type "A" multi section assembly 203 mm wide x 203 mm high (72" wide x 96" high) or 914 mm wide x 1219 mm high (144" wide x 48" high) vertical mount only. Nailor Model D1201SS c/w factory sleeve.
- .4 Acceptable manufacturers are:
  - .1 Nailor Industries Inc.
  - .2 Greenheck Fan Corporation
  - .3 E.H. Price Ltd.
  - .4 Ruskin Company
  - .5 Ventex/Alumavent

## 2.7 FLEXIBLE CONNECTION MATERIAL

- .1 Waterproof indoor-outdoor woven fibreglass fabric coated on both sides with a specially compounded synthetic rubber, off-white in colour, flexible material between the fan discharge and the casing opening, with spring thrust restraints secured to welded brackets on the fan housing and by steel rods through the fan casing with a steel back-up plate. Acceptable products are:

- .1 Duro Dyne Canada Inc. "DUROLON"
- .2 DynAir 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 to produce a material with an operating temperature range of from -50°C to 260°C (-60°F to 500°F). Acceptable products are:
  - .1 Duro Dyne Canada Inc. "Thermofab"
  - .2 DynAir Inc. "SILICON HI-T"

## 2.8 COMBINATION FIRE/SMOKE DAMPERS:

- .1 Nailor Series 1220, multi-blade type, fail-safe, dynamic, galvanized steel (unless otherwise specified) combination fire/smoke dampers, ULC classified to Standard CAN/ULC-S112 with NFPA 90A, 92A 92B, 1 1/2 hour fire rated, leakage Class I smoke rated, normally closed, low pressure drop design, dynamically tested, type "B" or "C" as required, each complete with:
  - .1 Accessories: jamb and blade seals, linkage concealed in the frame, a steel sleeve and retaining angles to suit the fire barrier opening,
  - .2 Controlled closure device: Electric Resettable Link (ERL) heat sensor to close and lock the damper without disengaging the actuator
  - .3 Actuator: Electric 115 volt, spring return actuator to automatically close the damper upon receiving an external signal, and to automatically open the damper when the system is reset with damper position indicators. Actuator shall be ULC listed to CAN/CSA-E60730-1:02 and suitable for use in air plenums.
  - .4 End Switch: Provide multiple actuator end switches to monitor the position (open/close) of the damper. One to be connected to Fire Alarm System, one to be connected to BAS system.
  - .5 Damper Test Switch: Provide remotely installed "momentary" push button test switch to "cycle test" the damper.
  - .6 Wiring: Provide all wiring to integrate and interface the damper with its control and monitoring systems (inclusive of fire alarm, smoke detectors, BAS, switches, actuator, power supply, etc.)
- .2 Acceptable combination fire/smoke dampers are:
  - .1 Nailor Industries Inc.
  - .2 Greenheck
  - .3 E.H. Price Ltd.

## 2.9 FIRE STOP FLAPS:

- .1 Nailor Industries Inc. or approved equivalent Model 0716A rectangular or Model 0722A round, adjustable volume control, ULC listed and labelled, blade type galvanized steel fire stop flaps, each complete with ceramic fibre insulation on both sides of the blade, and, unless otherwise specified, a 74 degrees C (165 degrees F) fusible link.

## 2.10 DUCT ACCESS DOORS

- .1 Nailor Model Series 0800 flat oval access doors or approved equivalent complete with safety chain. Frame shall be of flat oval design, double flange frame mounting type M-1, die-formed of minimum 0.85 mm (22 ga) galvanized steel. Door shall be die-formed of minimum 0.85 mm (22 ga) galvanized steel and be of double skin construction with 25 mm (1") of insulation fully enclosed within and an integral bulb type seal fastened to the door with sizes suitable in all respects for the purpose for which they are provided, and, unless otherwise specified in the

Contract Documents, constructed of the same material as the duct they are associated with. Manufacturer shall submit leakage data tested to a minimum of 2 kPa (8" w.g.).

.2 Acceptable manufacturers are:

- .1 Nailor Industries Inc.
- .2 Ductmate Industries Inc.
- .3 Ruskin Company

#### 2.11 DUCTWORK DRAIN POINT

- .1 Ductmate Canada Ltd. "Moisture Drain", or approved equivalent 20 mm (3/4") in diameter moisture drains with galvanized sheet metal funnel. The threaded drain, nut, and cap shall be corrosion resistant.

#### 2.12 INSTRUMENT TEST PORTS

- .1 Duro Dyne of Canada Ltd. #TH1 or #IP2 (to suit insulation thickness where applicable) or approved equivalent gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

#### 2.13 ACOUSTIC PANELS

- .1 Vibro-Acoustics Ltd. type "PS 1", 100 mm (4") thick tongue and groove panels with acoustic media meeting NFPA 90A requirements sandwiched between a minimum 1.31 mm thick (18 ga) G90 galvanized exterior sheet steel and 1.0 mm thick (20 ga) G90 galvanized interior sheet steel, with the airside face perforated and with acoustic performance as follows:
  - .1 125 Hz octave band - 0.74 absorption coefficient
  - .2 250 Hz octave band - 1.06 absorption coefficient
  - .3 500 Hz octave band - 1.07 absorption coefficient
  - .4 1000 Hz octave band - 0.1.05 absorption coefficient
  - .5 2000 Hz octave band - 1.03 absorption coefficient
  - .6 4000 Hz octave band - 0.91 absorption coefficient
  - .7 63 Hz octave band – 18 transmission loss
  - .8 125 Hz octave band - 21 transmission loss
  - .9 250 Hz octave band - 27 transmission loss
  - .10 500 Hz octave band - 37 transmission loss
  - .11 1000 Hz octave band - 48 transmission loss
  - .12 2000 Hz octave band - 60 transmission loss
  - .13 4000 Hz octave band - 58 transmission loss
  - .14 8000 Hz octave band - 54 transmission loss
- .2 600 mm wide x 1800 high x 100 mm thick (24"x 72"x 4") access doors mounted in a 3.51 mm thick (10 ga) galvanized steel angle frame shall be provided for each component section and include the following: "P" gasket, 2 cam-type DynAir Model ADH-100 heavy duty cast handles electroless nickel plated with stainless steel lockout nuts on both sides of door for easy access and full length stainless steel piano hinges, 300 mm x 300 mm (12"x 12") wire reinforced sealed double glazed thermally broken inspection window in a neoprene U-gasket.
- .3 Bolted panels of the internal flange butt connection type shall be provided for equipment removal.

- .4 Structural steel shall be provided by the manufacturer so the maximum deflection of the assembled panels is  $L/180$  and the steel to steel connections shall be fully welded. Provide a drawing signed and sealed by a Professional Engineer.
- .5 Acceptable manufacturers are:
  - .1 Vibro-Acoustics Ltd.
  - .2 Kinetics Noise Control (Vibron)
  - .3 Haakon Industries Canada Ltd.
  - .4 Racan Carrier Co.
  - .5 Alpha Industries Ltd.

#### 2.14 ACOUSTIC LINING

- .1 Where indicated on the Contract Drawings, line ductwork inside with fibreglass acoustic duct insulation. Insulation shall comply with ULC S110-M.
- .2 Facing for low velocity duct liner (maximum 12.2 m/s (2,400 fpm)) shall be a tightly bonded mat, stenciled in accordance with NFPA 90.
- .3 Facing for circular ducts and medium/high velocity ductwork (over 12.2 m/s (2,400 fpm)), or where indicated on the Contract Drawings shall be with perforated, minimum 28 percent open area, with minimum 0.85 mm (22 ga) thickness galvanized steel finish.
- .4 Provide lining with the following minimum thickness and density:
  - .1 In ductwork 25 mm (1") at 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>), unless otherwise noted on the Contract Drawings.
  - .2 In plenums 50 mm (2") at 32 kg/m<sup>3</sup> (2 lb/ft<sup>3</sup>).
  - .3 In linear slot diffuser plenums 13 mm (0.5") at 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>).
- .5 Lining media shall have a maximum flame spread classification of 25, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723. Furthermore, maximum fuel contribution and smoke development rating shall be 50, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723.
- .6 Lining shall be suitable for duct velocity of 30.5 m/s (6,000 fpm), without erosion damage.
- .7 Media shall have the following physical properties:
  - .1 Maximum thermal conductivity of 1.42 W/m<sup>2</sup> °C (0.24 Btu/ft<sup>2</sup> hr °F), at 25 mm (1") thickness and 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>) density.
  - .2 Minimum sound absorption coefficient (NRC) of 0.7, at 25 mm (1") thickness and 24 kg/m<sup>3</sup> (1.5 lb/ft<sup>3</sup>) density in accordance with ASTM C423.
- .8 Acceptable manufacturers are:
  - .1 Johns-Manville Inc.
  - .2 Knauf Insulation Ltd.
  - .3 Manson Insulation Inc.

#### 2.15 WIRE MESH (BIRD SCREEN)

- .1 Galvanized steel, 304 stainless steel (indoors), 316 stainless steel (outdoors), or aluminum mesh, 12 mm x 12 mm (1/2" x 1/2") secured in a rigid galvanized steel, 304 stainless steel (indoors), 316 stainless steel (outdoors), or aluminum framework and sized as indicated on the Drawings. Minimum wire diameter of 1.6002 mm (0.0630").



## 2.16 FILTER BOX

- .1 Camfil Farr "4P Glide/Pack", 1.5 mm thick (16 ga) galvanized or stainless steel construction as required with pre-drilled standing flanges to mate to ductwork or equipment; all components are weatherproof for interior or exterior installation, c/w Dual-access doors for filter service from either side of the unit, replaceable door hinges, UV resistant star-style handles, High-memory sponge neoprene door gaskets, sponge door gasket, polypropylene fin seal on the filter track, aluminum mounting track for the universal holding frame allowing for the application of any nominal 50 mm (2") deep air filter, operational to  $\pm 1500$  Pa (6.0" w.g).
- .2 Camfil Farr "R30/30 WR" replaceable, multi-layered non-cellulose media that effectively repels water while capturing dust, lint, pollen and other particulate contaminants. The media is enclosed in a waterproof frame made of proprietary board material that will not deform or degrade throughout the service life of the filter, as per the Drawing schedule, ULC listed and labelled Class 2 for pre-filters supplied to the site in sealed manufacturer's cartons in quantities sufficient for an initial installation at fan start-up, and two sets of spare filters. The filter shall have a minimum efficiency of not less than 25-30 % and an arrestance value of 90-92% on ASHRAE Standard 52.1-1992 and shall meet a MERV rating of 13 when tested in accordance with ASHRAE Standard 52.2.

## 2.17 FILTERS FOR COMMISSIONING

- .1 Supplied with each air handling unit as follows:
  - .1 Construction filter - Camfil Farr "CG-3000" 25 mm (1") thick, high-loft fibreglass (white/yellow), MERV 8, synthetic roll media secured in place in the filter section prior to shipping.

## 3 EXECUTION

### 3.1 INSTALLATION OF SPLITTER DAMPERS

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on the Drawings. Install splitter dampers so they cannot vibrate and rattle and so that the damper operation mechanisms are in an easily accessible and operable location.

### 3.2 INSTALLATION OF TURNING VANES

- .1 Provide turning vanes in all ductwork elbows (supply, exhaust, return) where due to site installation routing and duct elbow radius of less than one and a half ( $1\frac{1}{2}$ ) times width (smooth radius elbows with a R/W of 1.5) is not possible, turning vanes and splitter vanes shall be in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified in the Contract Documents.

### 3.3 INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS

- .1 Provide manual balancing dampers in all open end ductwork, in all supply and return air duct mains, in all branch ducts, at each individual grille, register, diffuser and wherever else shown and/or specified in the Contract Documents.
- .2 Install the dampers so that the operating mechanism is accessible and positioned for easy operation, and so that the dampers cannot move or rattle.

- .3 Where a duct for which a balancing damper is required has dimensions larger than the dimensions of the 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.

#### 3.4 **INSTALLATION OF BACKDRAFT DAMPERS**

- .1 Provide backdraft dampers where shown on the Drawings.
- .2 Install and secure the dampers so that they cannot move or rattle.

#### 3.5 **INSTALLATION OF CONTROL DAMPERS**

- .1 Provide control dampers for all exhaust fans, exhaust air louvres, air intake louvres, and wherever else shown on the Drawings.
- .2 Install dampers in accordance with manufacturer's Installation Instructions.
- .3 Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet Contractor shall furnish any access doors in ductwork or plenums required to provide this access. The Construction Contractor shall furnish any access doors required in walls, ceilings, or other general building construction.
- .4 Install dampers square and free from racking.
- .5 The Contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.
- .6 Do not compress or stretch the damper frame into the duct or opening.
- .7 Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.
- .8 Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft
- .9 Install connections to actuators as specified in Section 25 00 00.

#### 3.6 **INSTALLATION OF FUSIBLE LINK (FIRE) DAMPERS**

- .1 Provide fusible link dampers where shown and/or specified on the Drawings. Ensure that the damper rating (1.5 or 3 hr.) is suitable for the fire barrier it is associated with.
- .2 Fusible link dampers shall be type "B" or type "C" (as required) with the folded curtain blade out of the air stream. The use of type "A" dampers with the curtain blade in the air stream shall not be permitted without prior approval, in writing, from Consultant.
- .3 Install dampers with retaining angles on all four sides of the sleeve on both sides of the damper and connect with ductwork in accordance with the damper manufacturer's instructions and details to meet National Building Code requirements.
- .4 Provide expansion clearance between the damper or damper sleeve and the opening in which the damper is required. Ensure that the openings are properly sized and located, and that all voids between the damper sleeve and the opening are properly sealed to maintain the rating of the fire barrier.
- .5 Where the size of the fire barrier opening requires the 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.

- .6 Operational Testing: All fusible link dampers shall be tested in accordance with NFPA 80 and NFPA 105 as follows:
  - .1 An operational test shall be conducted after the building's HVAC system has been balanced.
  - .2 The operational test shall be conducted under normal HVAC airflow conditions as well as static flow conditions. The damper shall fully close/seal under both test conditions.
  - .3 After the installation of a damper is completed, an operational test shall be conducted to verify that:
    - .1 The dampers shall fully close from the open position.
    - .2 It shall be verified that the system airflow where the damper is installed is within the design velocity.
  - .4 All inspections and testing shall be documented, indicating the location of the fire damper, date(s) of inspection, name of inspector, and deficiencies discovered. The documentation shall have a space to indicate when and how the deficiencies were corrected rating of the damper listing.
  - .5 Demonstrate re-setting of all fire dampers to the Owner's and Project Co.'s OMR representative after fan start/air handling unit startup and air balancing.
- .7 After testing, all fusible links shall be reset into the "closed" position, holding the damper blades in the in the open position, allowing airflow to pass through.

### 3.7 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or casings connect to fans, and wherever else shown or specified in the Contract Documents.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum 24 ga) to each edge of the flexible fabric and to the fan, duct, plenum, etc., in accordance with Figures 7-8 and 7-9 in SMACNA HVAC Duct Construction Standards Metal and Flexible Third Edition.
- .3 Ensure that connections to the flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

### 3.8 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 (upstream and downstream), fire dampers, smoke dampers, duct mounted smoke detectors, control and operating dampers, equipment requiring maintenance, duct mounted instrumentation or control devices.
- .2 Install in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .3 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure that the doors are properly located for damper maintenance.
- .4 When requested, submit a sample of proposed duct access doors for review.
- .5 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 the ductwork to suit the access door installed.

### 3.9 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.

### 3.10 INSTALLATION OF ACOUSTIC PANELS

- .1 Provide acoustic panels for plenums where shown on the Drawings. Integrate acoustic plenums with standard casings and plenums.
- .2 Install acoustic panels in strict accordance with the manufacturer's instructions. Seal panels with acoustic caulking where pipes, ducts or conduit penetrate and make air and watertight.
- .3 Provide floor to ceiling high acoustic plenums where shown on the Drawings, each complete with all required framing, including framing for access doors and other openings, each structurally designed to resist excessive deflection or bowing, constructed to be air-tight when subjected to a pressure differential of 2.48 kPa, and designed so that any one panel can be removed without dismantling the entire plenum.
- .4 Provide acoustic type access doors where shown on the Drawings, and provide acoustic caulking at all locations where acoustic plenums abutt building walls or slabs, and at all points where pipe, ducts or conduit penetrate acoustic panels.

### 3.11 INSTALLATION OF ACOUSTIC LINING

- .1 Provide acoustic lining in the following locations:
  - .1 Wherever shown and/or specified on the Drawings.
  - .2 Supply ductwork downstream of variable air volume and constant volume boxes for a distance of 2.4 m (8') measured along the duct and outward from the box in all directions.
- .2 Install lining in accordance with the requirements of 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 "A" of Fig. 2-19, Flexible Duct Liner Installation, found in the SMACNA manual referred to above.

### 3.12 INSTALLATION OF WIRE MESH (BIRDSCREEN)

- .1 Provide framed wire mesh panels over openings in ducts and/or walls where shown and/or specified on the Drawings. Rigidly secure in place but ensure the panels are removable.
- .2 Match ductwork material wherever possible and/or as specified on the Drawings.

### 3.13 INSTALLATION OF FILTER BOX

- .1 Provide filter box as shown and connect to ductwork or equipment as indicated in the Contract Documents.
- .2 Provide filters and install in filter rack.
- .3 Provide two spare sets of filters for each filter box.

**END OF SECTION 23 33 00**

## 1 GENERAL

### 1.1 REFERENCE STANDARDS

- .1 Air Movement and Control Association (AMCA)
  - .1 AMCA Publication 511, Product Rating Manual for Air Control Devices.
- .2 Air Conditioning, Heating, and Refrigeration Institute (AHRI)
  - .1 ANSI/AHRI 885, Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
- .3 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 36B-63, Method of Testing for Rating the Acoustic Performance of Air Control and Terminal Devices.
  - .2 ASHRAE Standard 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA, HVAC Duct Construction Standards - Metal and Flexible.
- .5 National Building Code 2015 (NBC)

### 1.2 SUBMITTALS

- .1 Shop Drawings:
  - .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
  - .2 Submit product literature for all equipment in this Section.
- .2 Colour Chart(s): Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.

### 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan (WMP).
- .4 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 GENERAL

- .1 Grilles, registers, and diffusers for inlets to exhaust and return air system and as outlet for supply air systems shall be sized shown on the Contract Drawings.
- .2 Refer to the Grilles and Diffusers Schedule at the end of the Section for additional details.
- .3 Where special colour finish or material is noted submit samples for the Consultant selection. Refer to the Contract Drawings for model and capacity.
- .4 Select all diffusers to provide uniform air coverage without overlap. Air velocity up to a height of 1800 mm (6 ft.) above the floor shall be 0.127 to 0.254 m/s (25 to 50 fpm).

- .5 Noise generated by diffusers shall be such that room sound pressure level does not exceed NC 32 with an 8 db room attenuation, the sound power level reference to 10 to –12 power watts.
- .6 Diffusers shall meet test requirements of ASHRAE Standard 36B-63, including air pattern and noise levels for air quantities from 10% to 110% of the required maximum air flow. Sound power tests shall be measured in accordance with ASHRAE Standards 36B-63.
- .7 In gypsum board or plaster ceiling applications, provide matching mounting frame. Colour to match ceiling.
- .8 In T-bar ceilings, manufacturer shall coordinate diffuser compatibility with T-bar ceiling specified by the architectural division. Colour shall match colour of ceiling tile in lay-in ceilings. Diffusers to suit ceiling grid as required imperial or metric.
- .9 Acceptable manufacturers are:
  - .1 E.H. Price Ltd.
  - .2 Nailor Industries Inc.
  - .3 Titus HVAC
  - .4 Krueger
  - .5 Enviro-Tec
  - .6 Metalaire
  - .7 Anemostat

## 2.2 SQUARE SUPPLY DUFFUSERS (S-1 & S-1A)

- .1 All diffusers shall be steel plaque diffusers constructed of square, coned metal with a powder coat finish.
- .2 Diffusers shall consist of a precision formed back cone of one-piece seamless construction which shall incorporate a round (or square) inlet collar of sufficient length for connecting rigid or flexible duct as shown.
- .3 An inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.
- .4 Typical neck sizes:
  - .1 S-1a, 100 mm diameter neck: Up to 40 L/s
  - .2 S-1a, 150 mm diameter neck: Up to 75 L/s
  - .3 S-1, 150 mm diameter neck: Up to 90 L/s
  - .4 S-1, 200 mm diameter neck: Up to 135 L/s
  - .5 S-1, 250 mm diameter neck: Up to 205 L/s

## 2.3 WALL AND DUCT SUPPLY GRILLES (S-2)

- .1 All supply registers shall be standard double deflection type with adjustable horizontal face bars and vertical rear bars.
- .2 Frame shall be gasketed. Construction shall be aluminum with prime coat. Registers larger than listed sizes shall be shop fabricated in sections such that the sections will appear as one integral register when installed.

- .3 The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be operable from the register face. The damper shall be coated or galvanized steel.

#### 2.4 LINEAR SUPPLY AND RETURN DIFFUSERS (S-3, R-3)

- .1 All diffusers shall be linear supply diffusers of the sizes, configurations and mounting types required by the ceiling type.
- .2 Pattern controllers shall be extruded aluminum with aerodynamically curved pattern for 180 degree throw control and airflow dampening if required.
- .3 The diffuser border shall be heavy extruded aluminum construction with extruded aluminum spacers and (mitered end flanges, open ends, flush end caps or angle end caps).
- .4 Frame shall be recessed into plaster or gypsum board with no mounting flange visible. All diffusers shall have a removable concealed fastening device. Colour shall match architectural ceiling and diffuser face shall be pre-coated with a protective lacquer finish.
- .5 In T-bar plug-in applications, provide diffuser with mounting clips to suit in continuous T-bar openings.

#### 2.5 EGGRATE RETURN GRILLE (R-1)

- .1 Return grilles shall be egg crate type with aluminum construction. Egg crate shall be 12 mm (1/2 in.) deep, formed of 12 mm (1/2 in.) wide aluminum strips on 12 mm (1/2 in.) centres. Strips shall be approximately 0.64 mm (0.025 in.) thick.
- .2 Grilles shall be enclosed in a channel frame for inverted T-bar mounting or with a flanged frame for plaster or gypsum ceiling mounting. Grilles shall lay on inverted T-bar ceiling suspension system.
- .3 Colour shall match adjacent ceiling tiles.

#### 2.6 RETURN, EXHAUST AND TRANSFER GRILLES (R-2, T-1)

- .1 Return, exhaust and transfer registers shall be standard return grilles with horizontal fixed bars set at approximately 45 deg. for wall returns and set straight for ceiling return.
- .2 The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be operable from the register face. The damper shall be coated or galvanized steel.
- .3 Door transfer grilles unless otherwise specified shall have finely spaced blades for a sight proof appearance and are designed for applications in doors or partitions with Sections as thin as 35 mm (1-3/8") with flat border and countersunk holes.
- .4 General appearance, type of material and finish shall match supply grilles within item 2.4.

### 3 EXECUTION

#### 3.1 INSTALLATION OF DIFFUSERS, REGISTERS, AND GRILLES

- .1 Provide grilles and diffusers where shown on the Drawings. Refer to the architectural drawings for actual locations of diffusers, grilles and registers and install to suit. The mechanical drawings show intent and number of diffusers, grilles and registers required.
- .2 Wherever possible, diffusers, registers, and grilles shall be the product of one manufacturer. Unless otherwise specified connect diffusers, registers, and grilles in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .3 Provide sheet metal plenums, constructed of the same material as the connecting duct, for linear grilles and/or diffusers where shown on the Contract Drawings. Construct and install the plenums in accordance with requirements of SMACNA HVAC Duct Construction

Standards Metal and Flexible. Where individual sections of linear grilles or diffusers are not equipped with a volume control device, equip the duct connection collar(s) with volume control device(s).

- .4 Install in accordance with manufacturer's instructions. Fit frame with gasket to prevent leakage and smudging. Install with flat head cadmium plated screws in countersunk holes where fastenings are visible.
- .5 For exposed ductwork installations, all connections to grilles shall be oversized and shall have in-turned flanges to meet the flange of the grilles and the duct. Out-turned or exposed flanges with screw mounting shall not be accepted.
- .6 For transfer air applications where air is transferred though a ceiling, partition or door provide grilles in all finished spaces. Provide transfer grille on both sides of the finished areas.
- .7 Install mounting frame tied into plaster and gypsum board ceilings to allow lay in type diffusers to rest on the frame.
- .8 Contractor shall caulk around edges of linear diffusers in installations with imperfect walls.
- .9 Paint ductwork visible behind air outlets matte black.
- .10 Confirm diffuser, register, and grille finishes prior to ordering.

#### 4 GRILLE AND DIFFUSER SCHEDULE

- .1 Model numbers based on EH Price selections.

Tag	Service	Model	Description	Finish	Integral volume damper	Mounting
S-1	S/A	SPD-24x24	Plaque ceiling diffuser, 24"x24" steel	B12 - white powder coat	No	Lay-in
S-1a	S/A	SPD-12x12	Plaque ceiling diffuser, 12"x12" steel, in 24"x24 frame	B12 - white powder coat	No	Lay-in
S-2	S/A	620-F-L-A	Louvred face, double deflection grille	Aluminum	Yes	Screw-in
S-3	S/A	SDS c/w SDA insulated plenum	Linear slot, 1200 mm long, 175mm inlet, 2-slot, 1" slot width	B12 - white powder coat	No	Lay-in
R-1	R/A	80	Eggcrate	Aluminum	No	Screw-in or Lay-in
R-2	R/A	630-F-L-A	Louvred face, single deflection, 45deg.	Mill	Yes	Screw-in
R-3	R/A	SDS	Linear slot, 1200 mm long, 2 slots, 1" slot width	B12 - white powder coat	No	Lay-in
T-1	T/A	STG1	Door Grille, sight proof	Mill	No	Screw-in

END OF SECTION 23 37 13



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Equipment Handbook for Chimney, Gas Vent, and Fireplace Systems, material requirements and design criteria
- .2 Canadian Standards Association (CSA):
  - .1 CAN/CSA B.139, Installation Code for Oil-burning Equipment.
  - .2 CAN/CSA B.149.1, Natural Gas and Propane Installation Code.
- .3 National Fire Protection Association (NFPA)
  - .1 NFPA 211, Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 Low Pressure Duct Standards for Fabricated Breeching and Smoke pipe.
- .5 Underwriters' Laboratories of Canada (ULC):
  - .1 ULC S636, Standard for Type BH Gas Venting Systems.
  - .2 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .6 National Building Code 2015 (NBC)

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
  - .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
  - .2 Provide the manufacturer's product literature of all catalogued components to be supplied. Include manufacturer's data sheets for certification, performance criteria, ratings, and physical dimensions and finishes.
  - .3 Submit marked up prints showing detailed locations of all devices mounted in or on flues, dimensioning their locations.
- .3 Engineering Calculations:
  - .1 Submit stack design calculations with the shop drawings. The breeching system shall be designed to compensate for all flue gas induced thermal expansions. The inner diameter for breeching and stack shall be verified by the manufacturer's computations. The computation shall be technically sound, shall follow ASHRAE calculation methods and incorporate the specific flow characteristics of the inner pipe.
- .4 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.

- .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan (WMP).
- .4 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 DOUBLE WALL, POSITIVE PRESSURE, HVAC APPLICATIONS (BOILERS)

- .1 The vent shall be of double wall, factory-built type, designed for use in conjunction with Category I, II, III or IV condensing or non-condensing gas-fired appliances or as specified by the heating equipment manufacturer.
- .2 Maximum continuous flue gas temperature shall not exceed 249°C (480°F).
- .3 Vent shall be listed for a minimum positive pressure rating of 1.49 kPa (6" W.C.) and shall have passed at 8.72 kPa (35" W.C).
- .4 The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All system components shall be ULC S636 Type BH listed and supplied from the same manufacturer.
- .5 Chimney shall be self-supporting up to 3m (10 ft.), any chimney's taller than 3m (10ft) shall be complete with guy-wire supports.
- .6 Chimney and breeching shall be complete with:
  - .1 Inner Liner: minimum 0.635 mm (24 gauge) in thickness, type AL 29-4C stainless steel, laterally braced to the outer casing at 120° intervals every 4.5 m (15').
  - .2 Air Gap: minimum 25 mm (1 in.) thick air space.
  - .3 Outer Casing: Non-corrosive outer casing minimum 0.635 mm (24 gauge) sheet, fabricated into the stack shape by rolling and welding with vertical joints offset 180°. The vent above the roof line shall have a 304L stainless steel outer shell.
  - .4 Drain connections: minimum 0.635 mm (24 gauge) in thickness, material to suit inner lining and outer casing materials, drain connection shall extended from the bottom of the outer casing where it shall be terminated with a screw-on 19 mm (3/4") – HPT.
  - .5 Exhaust Cone: minimum 0.635 mm (24 gauge) in thickness, material to suit inner lining and outer casing materials.
  - .6 Cleanout door: minimum 150 mm (6") in diameter, cleanout door shall be constructed of the same material as the inner liner and shall be welded to the inner liner, then extended out through the outer casing, with reinforcing around the outer casing opening, and equipped with a flanged bolt-on cover plate. Size cleanout door to suit actual size of stack diameter.
- .7 If equipment manufacturer's specifications require a different inner liner material, that material shall be used.
- .8 Product shall be listed for 50 mm (2 in.) clearance to combustibles
- .9 Chimney shall be complete with 15-year warranty from date of substantial completion.
- .10 Acceptable manufacturers are:
  - .1 Chiminée Lining E Inc.
  - .2 Duravent Group (Security Chimneys, Selkirk, Heatfab)
  - .3 Schebler Company.

## 3 EXECUTION

### 3.1 INSTALLATION OF VENTS FOR CONDENSING HVAC APPLICATIONS

- .1 Installation shall comply with manufacturer's written instructions and applicable codes and shall be complete with necessary boiler adapter kits, expansion joints, drains, braces, supports, cleanouts at the end of each horizontal section, roof flashings for installation by the Work of this Section, storm collars and rain caps.
- .2 Drain connections shall be piped back to the nearest floor drain complete with acid neutralization kit.
- .3 The joining of pipe sections must be made using the assembly band, the finishing band and the appropriate sealing material.
- .4 Roof penetrations shall be suitable for a combustible roof and shall be according to the manufacturer's detail drawings and installation instructions.
- .5 When installed according to the manufacturer's installation instructions the stack and its supporting system shall resist side loads at least 1.5 times the weight per foot of piping.
- .6 Height of chimney shall terminate 900 mm (3 ft.) above the roof line and at least 600 mm (2 ft.) higher than any portion of the building within 3000 mm (10 ft.). Chimney shall be free standing for heights up to 1800 mm (6 ft.).

**END OF SECTION 23 51 00**

1 GENERAL

1.1 SUMMARY

- .1 This Section includes packaged, factory-fabricated and assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for space heating hot water.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
  - .1 ANSI Z21.13 Gas-Fired Low Pressure Steam and Hot Water Boilers.
- .2 American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE/IESNA 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 American Society of Mechanical Engineers (ASME)
  - .1 ASME Boiler and Pressure Vessel Code
- .4 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA 250 Enclosures for Electrical Equipment.
- .5 National Fire Protection Association (NFPA)
  - .1 NFPA 54 National Fuel Gas Code
  - .2 NFPA 70 National Electrical Code

1.3 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- .3 Shop Drawings:
  - .1 General arrangement showing piping hook-ups, terminal points, instrumentation test connections.
  - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
  - .3 Foundations with loadings, anchor bolt arrangements.
  - .4 Electrical wiring diagram, burners, controls and flame safety control system.
  - .5 All miscellaneous equipment.
  - .6 Breeching and stack configuration.
  - .7 Noise levels generated by the boiler.
- .4 Engineering data to include"
  - .1 Boiler capacity and efficiency throughout the entire hot water supply temperature range and part fire conditions.
  - .2 Radiant heat loss at 100% design capacity.
- .5 Closeout submittals
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties

- .2 Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

#### 1.4 **QUALITY ASSURANCE**

- .1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- .2 ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- .3 "ASHRAE/IESNA 90.1 Compliance" Paragraph may be required to comply with Project requirements or authorities having jurisdiction. Also, LEED Prerequisite EA 2 requires compliance with ASHRAE/IESNA 90.1.
- .4 ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- .5 ANSI Compliance: Boilers shall be compliant with ANSI Z21.13 test standards for US and Canada.
- .6 CSA Compliant: Boilers shall be compliant with CSA certification.

#### 1.5 **COORDINATION**

- .1 Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

#### 1.6 **WARRANTY**

- .1 Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - .1 Warranty Period for Fire-Tube Condensing Boilers:
    - .1 Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship and failure due to thermal shock.
    - .2 All other components shall carry a one year warranty from date of boiler start up.

### 2 **PRODUCTS**

#### 2.1 **MANUFACTURERS**

- .1 Basis-of-Design Product: Lochinvar Knight KHB199 Boiler.
- .2 Acceptable alternates from Aerco, Viessmann, De Dietrich, Weil-McLain, Riello.

#### 2.2 **CONSTRUCTION**

- .1 The boiler shall bear the ASME "H" stamp for 80 psi working pressure and shall be National Board listed. The boiler shall have a fully welded, stainless steel, fire tube heat exchanger. There shall be no banding material, bolts, gaskets or "O" rings in the pressure vessel construction. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. The condensate collection basin shall be constructed of welded stainless steel
- .2 The boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard. The boiler shall operate at a minimum of 95% AFUE Efficiency as registered with AHRI. The boiler shall be certified for indoor installation.

- .3 The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided for observing the burner flame and combustion chamber. The burner shall be a premix design constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide smooth operation at all modulating firing rates. The boiler shall be supplied with a negative pressure regulation gas valve and be equipped with a pulse width modulation blower system to precisely control the fuel/air mixture to the burner. The boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.
- .4 The boiler shall utilize a 24 VAC control circuit and components. The control system shall have a factory installed display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi; outlet water temperature sensor with a dual thermistor to verify accuracy; system supply water temperature sensor; outdoor air sensor, flue temperature sensor with dual thermistor to verify accuracy; low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.
- .5 The boiler shall feature the "SMART SYSTEM™" control which is standard and factory installed with 128 x 128 resolution display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities, USB drive for simple uploading of parameters and a PC port connection for connection to a local computer for programming and trending. A secondary operating control that is field mounted outside or inside the appliance is not acceptable. The boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The boiler shall have a built-in "Cascade" with leader redundancy to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal "Cascade" function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The boiler shall be capable of remote communication via optional CON-X-US™ Remote Connectivity with the capability of historical trending and sending text message or email alerts to notify the caretaker of a boiler alarm and remote programming of onboard boiler control. The control must have optional capability to communicate via Modbus protocol with a minimum of 46 readable points. The boiler shall have an gateway device which will allow integration with BACNet/IP protocols. Refer to control drawings and sequence of operation for additional requirements.
- .6 The "SMART SYSTEM™" control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0-10 VDC output signal shall control a variable speed boiler pump to keep a fixed Delta T across the boiler regardless of the modulation rate. The boiler shall have the capability to receive a 0-10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues such as erratic temperature cycling.
- .7 The boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 46 connection points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Low Water Cut Off, Louver Proving Switch, Tank Thermostat, Domestic Hot Water Building Recirculation Pump Contacts, Domestic Hot Water Building Recirculation Temperature Sensor Contacts, Remote Enable/Disable, System Supply Temperature Sensor, Outdoor Temperature Sensor, Tank Temperature Sensor, BACNet/IP Building Management System Signal and Cascade Control Circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single

phase on all models. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump.

- .8 The boiler shall be installed and vented with a Direct Vent system with vertical roof top termination of both the exhaust vent and combustion air. The flue shall be Category IV approved material constructed of CPVC, Polypropylene or Stainless Steel. A separate pipe shall supply combustion air directly to the boiler from the outside. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet. The air inlet must terminate on the rooftop with the exhaust.
- .9 The boiler shall be suitable for use with polypropylene glycol up to a 50% concentration. The de-rate associated with the glycol will vary per glycol manufacturer.
- .10 Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

## 2.3 **CONTROLS**

- .1 Refer to 25 00 00 – Building Automation System (BAS) and 25 95 00 series – Control Sequences for building control requirements.

## 2.4 **SOURCE QUALITY CONTROL**

- .1 Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- .2 Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

## 3 **EXECUTION**

### 3.1 **EXAMINATION**

- .1 Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
  - .1 Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in of piping and electrical connections.
- .2 Examine mechanical spaces for suitable conditions where boilers will be installed.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 **BOILER INSTALLATION**

- .1 Install boilers on concrete housekeeping pad and level, as required.
- .2 Install with adequate clearance as required by code and as per manufacturer's recommendations.
- .3 Install gas-fired boilers according to NFPA 54.
- .4 Assemble and install boiler trim.
- .5 Install electrical devices furnished with boiler but not specified to be factory mounted.
- .6 Install control wiring to field-mounted electrical devices.

### 3.3 **CONNECTIONS**

- .1 Install piping adjacent to boiler to allow service and maintenance.

- .2 Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- .3 Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.
- .4 Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
- .5 Install piping from safety relief valves to nearest floor drain.
- .6 Boiler Venting:
  - .1 Install flue venting kit and combustion-air intake.
  - .2 Connect full size to boiler connections.
- .7 Provide neutralization kit.

### 3.4 **FIELD QUALITY CONTROL**

- .1 Perform tests and inspections and prepare test reports.
  - .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- .2 Tests and Inspections:
  - .1 Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
  - .2 Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  - .3 Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - .4 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - .1 Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    - .2 Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- .3 Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

### 3.5 **DEMONSTRATION**

- .1 Engage a factory representative or a factory-authorized service representative for boiler startup. Start-up sheet shall be completed and a copy shall be sent to the Consultant and the Manufacturer. A combustion analysis shall be completed and the gas valve adjusted per the Installation and Operations manual and note in start-up report.
- .2 Factory representative or a factory-authorized representative shall provide Project Co. and Owners training to instruct maintenance personnel to adjust, operate, and maintain boilers.

**END OF SECTION 23 52 15**



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section VIII for Unfired Pressure Vessels.
- .2 Air-Conditioning, Heating and Refrigeration Institute (AHRI)
  - .1 ANSI/AHRI 550/590, Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle Canadian Standards Association (CSA International), CSA B52, Mechanical Refrigeration Code.
  - .2 AHRI 370 - Standard for Sound Rating of Large outdoor Refrigerating and Air-conditioning Equipment.
  - .3 ANSI/ASHRAE 15, Safety Standard for Refrigeration Systems and Designation and Classification of Refrigerants.
  - .4 UL 1995 and NEC standards and be UL or ETL listed.
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .4 Canadian Standards Association (CSA International)
  - .1 CSA B52, Mechanical refrigeration code.
- .5 Ontario Building Code (OBC).
  - .1 .2 Seismic application in accordance with the Ontario Building Code (OBC)
- .6 EPS 1/RA/3E, Code of Practice for the Reduction of Chlorofluorocarbons Emissions from Refrigeration and Air Conditioning Systems Canadian Environmental Protection Act Code of Practice

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submittals:
  - .1 Submit shop drawings and product data in accordance with the specifications.
  - .2 Chiller capacity and efficiency throughout the entire chilled glycol supply temperature range. Heating capacity and efficiency throughout the entire heating glycol supply temperature range.
  - .3 Dimensioned plan and elevation view, including required clearances, and location of all field piping and electrical connections.
  - .4 Product data indicating rated capacities, weights, specialties, and accessories.
  - .5 Single line schematic drawing of the field power hookup requirements, indicating all items that are furnished.
  - .6 Diagram of control system indicating points for field interface and field connection. Diagram shall fully depict field and factory wiring.
  - .7 Indicate the following:
    - .1 General arrangement showing terminal points, instrumentation test connections.

- .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
- .3 Foundations with loadings, anchor bolt arrangements.
- .4 Piping hook-ups.
- .8 Summaries of all auxiliary utility requirements such as: electricity, water, air, etc. Summaries shall indicate the quality and quantity of each required utility.
- .9 Noise levels generated by the chiller.
- .10 Manufacturer's certified performance data at full load plus IPLV or NPLV.
- .11 Installation and Operating Manuals.
- .3 Operations and Maintenance Data
  - .1 Include manufacturer's descriptive literature, installation checklist, start-up instructions and maintenance procedure.

### 1.3 QUALITY ASSURANCE

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Underwriters' Laboratories (UL) 1995 -- Standard for Heating and Cooling Equipment.
- .3 Manufactured facility to be International Organization for Standardization (ISO) 9001.
- .4 Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with HFC-410A refrigerant and oil. In addition, a factory functional test to verify correct operation by cycling condenser fans, closing compressor contacts and reading data points from temperature and pressure sensors.
- .5 Chiller manufacturer shall have a factory trained and supported service organization that is within a 75 mile (120.7 km) radius of the site.
- .6 Qualifications: equipment manufacturer must specialize in the manufacturer of the products specified and have five years' experience with the equipment and refrigerant offered

### 1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with manufacturers installation instructions.
- .2 Deliver materials to site in its original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.
- .4 Protect modules on site from physical damage after unloading.

### 1.5 WARRANTY AND MAINTENANCE

- .1 The chiller Manufacturer's warranty shall cover parts and labor costs for the repair or replacement of defects in material or workmanship, and include refrigerant for the entire unit, for a period of one year and the compressor shall have warranty for a period of five years from Substantial Performance of the Work. Warranty support shall be provided by a factory authorized service representative.
- .2 Maintenance of the chillers in accordance with the Manufacturer's recommendations as published in the installation and maintenance manuals shall be the responsibility of factory authorized service representative for the first year coinciding with the warranty period. The minimum maintenance shall include monthly checks to verify that the unit is operating correctly.

- .3 After each service/maintenance call the Contractor shall submit a service report to the Owner listing the checks, test and activities performed. Report all deficiencies (actual or potential), recommendations to the facility operator and the Owner and overall general condition of the chiller.
- .4 The factory authorized service representative shall be responsible for the start-up and shutdown of the unit during the first cooling season.
- .5 The 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. The warranty period shall commence at the date of initial startup and shall continue for a period of one year not to exceed 18 months from shipment.

## 2 PRODUCTS

### 2.1 HEAT RECOVERY CHILLER

#### .1 General:

- .1 Each heat recovery chiller module shall be assembled from formed galvanized sheet and be enclosed with epoxy painted formed aluminum panels. The heat recovery chiller modules shall be shipped individually and assembled on site. Each module shall be fully charged with refrigerant and factory tested for capacity and controller functions prior to shipment. Heat recovery chiller modules must be built for single point power supply connection to a central distribution block. The electrical distribution panel shall incorporate circuit breakers to provide branch circuit overload protection and electrical isolation for each heat recovery chiller module. Electrical supply to each module shall consist of flexible conduit. No electrical connection to a module shall carry the load of more than that module. The electrical supply connections shall be factory assembled and shipped with each module for field connection into the electrical distribution panel.
- .2 The heat recovery chiller module is designed to use a water-cooled condenser in each module to condense hot refrigerant gas to heat a fluid when there is requirement for heat recovery. If there is no heat recovery requirement, the refrigerant shall be redirected and rejected to the atmosphere via the air-cooled condenser.
- .2 **Frame:** Frame shall be constructed of formed 12-gauge sheet metal externally coated with white painted finish and internally coated in black
- .3 **Cabinet:** Cabinet panels are made of formed aluminum sheet metal externally coated with white painted finish and internally coated in black. The cabinet enclosure shall include easily removable access panels for service. Access panels shall be removable via stainless steel fasteners and retaining clips. Module shall not require access via sheet metal screws or protruding threaded fasteners.
- .4 **Compressors:** Hermetically sealed scroll compressor on each refrigeration circuit each with rotalock connections, crankcase heater, oil level sight glasses, suction gas-cooled motor with solid-state sensors in the windings for overload protection, and in-line circuit breaker. There shall be two, independent compressors and refrigerant circuits per module. Compressors shall be mounted to the heavy gauge steel frame with rubber-in-shear isolators.
- .5 **Evaporators:** Dual circuit, brazed plate evaporator in each module constructed of 316 stainless steel plates and copper brazing. The supply and return fluid piping connections to each evaporator shall include manual isolation valves to allow servicing of each module individually, while the remaining modules continue to operate. The fluid connections to each evaporator shall use roll grooved couplings for service convenience and ease of installation. Evaporators shall be insulated with  $\frac{3}{4}$ " closed cell insulation. The minimum working pressure shall be 650 psi.

- .6 **Electronic control valves:** Each air-cooled heat recovery module shall include an electronic isolation valve on the evaporator and water-cooled heat recovery condenser (where applicable) that allows system flow to the active module to match the cooling or heating requirements to the system load. The valves shall have a minimum opening cycle time of not less than 35 seconds between the fully closed and open position. The valves shall have a minimum close off pressure of not less than 75 psi.
- .7 **Filters:** A 40-mesh industrial grade filter strainer shall be factory installed between the header system and each evaporator and water-cooled heat recovery condenser inlet. The strainer shall be serviceable by individual isolation valves that permit each strainer to be removed and cleaned without shutting down fluid flow or power to the entire system and allowing the remaining modules to continue to operate. In-line strainers that require complete system shutdown for service and isolation are not acceptable.
- .8 **Condenser fan motors:** The condenser fan motors shall be maintenance free and highly efficient Electronically Commutated Motors (ECM) with energy reduction capabilities of up to 35%. These variable speed fan assemblies shall vary fan motor RPM to maintain the refrigeration pressure of the condensing chiller modules.
- .9 **Condenser Coil:** Aluminum fins mechanically bonded to copper tubes with integral subcooling circuits. The coils shall be sized to provide full heat of rejection at jobsite elevation above sea level, at a maximum 25 degree F temperature difference between the condensing temperature and ambient air temperature. The coils shall be factory tested to a minimum of 600 psig.
- .10 **Water Cooled Heat Recovery Condenser:** Dual circuit, brazed plate condenser in each module constructed of 316 stainless steel plates and copper brazing. The supply and return fluid piping connections to each condenser shall include electronic modulating and manual isolation valves to allow servicing of each condenser individually while the remaining modules continue to operate, to allow for variable flow and for maximizing the leaving fluid temperature in reduced load conditions. The fluid connections to each condenser shall use roll grooved couplings for service convenience and ease of installation. The minimum working pressure shall be 650 psi.
- .11 **Refrigerant piping:** Piping shall be Type L seamless copper, and shall have an insulated suction line using closed cell pipe insulation, compressor rotalock service valves, solenoid valves for compressor pumpdown, and Schrader service valves in the suction, discharge, and liquid lines. Refrigerant specialties shall be included to allow for the use of the water source and air cooled condensers for heats of rejection.
- .12 **Fluid Piping:** The fluid piping for the chiller evaporator fluid and water cooled heat recovery condenser fluid shall be Schedule 40 steel and shall be insulated using closed cell pipe insulation to prevent condensation and heat loss. The module shall have service valves for the independent isolation of each evaporator and condenser, without affecting the fluid flow to the remaining evaporators and condensers. Each heat recovery chiller module shall connect to the adjacent module using roll grooved steel couplings and neoprene gaskets. Any type of module-to-module connection external to the modules is unacceptable.
- .13 **Refrigerant Liquid Receiver:** Provide a refrigerant receiver on each refrigeration circuit for flooded condenser head pressure control, sized to accommodate the required system pump down capacity. The receivers shall be provided with service valves for service isolation. A pressure relief valve shall be installed on the refrigerant receiver and piped to the outside of the chiller cabinet. Heat tracing shall be provided on the receivers to keep the refrigerant temperature warm during off cycles to prevent low pressure trips when a compressor starts.
- .14 **Flooded Condenser Head Pressure Control:** Provide flooded condenser head pressure control allow operation in ambient temperatures down to -20° F, using a larger charge of refrigerant with a refrigerant receiver to fill the condenser coil with up to 80% of liquid refrigerant such that it effectively reduces the condenser capacity. Provide a head pressure control valve on each circuit to store excess refrigerant in the liquid refrigerant receiver during

warmer ambient temperatures when the condenser coil is not flooded. Ensure the chiller module is capable of maintaining minimum suction and head pressures during low ambient operation.

- .15 **Controls:** The primary heat recovery chiller module shall incorporate the primary microprocessor controller. The primary microprocessor shall communicate with a secondary microprocessor in each module via a local network communications protocol. Each microprocessor shall include; operational switches for each compressor; high and low refrigeration pressure switches; low pressure pump down switches; anti-short cycling compressor timers; minimum compressor run timers; and phase monitor to protect against low voltage, phase unbalance, phase loss, and phase reversal conditions. Each air cooled heat recovery chiller module shall incorporate its own flow safety switch for system redundancy and service isolation valve to permit changing of each individual flow switch while the remainder of the chiller modules are operational. Systems incorporating only one system flow switch are not acceptable. The primary microprocessor controller shall read all analog and fault port values from all secondary module controllers and shall be capable of passing values, compatible with the BACnet/IP protocol, to the Building Automation System.

.16 **Programmable Logic Controller (PLC)**

The PLC shall provide the following minimum functions and alarms:

- .1 Adjustable fluid temperature set point
- .2 Multiple stage compressor control, including compressor rotation to provide even compressor usage and wear.
- .3 Reset temperature control set point based on decreased load
- .4 High and low fluid temperature alarm set points
- .5 Fluid inlet and outlet temperature
- .6 Suction and discharge refrigeration pressures on each refrigeration circuit
- .7 Compressor run status
- .8 Current alarm status
- .9 Demand load
- .10 Compressor run hours
- .11 Number of compressors starts
- .12 Alarm logging with minimum of previously 100 logged alarms with time and date of each occurrence
- .13 Remote start/stop input
- .14 Dry contact for general alarm
- .15 'Smart' compressor demand distribution algorithm across chiller bank, which seamlessly allows unavailable modules to be placed out of sequence and available modules to be placed back in sequence
- .16 Provide BMS with the information for automatic variable flow control
- .17 Maintaining minimum flow for chilled water and hot water loops even with no compressors running
- .18 'Smart' compressor rotation algorithm within a module which accounts for compressor availability and safety timers
- .19 Stand-alone fail-safe mode for each module should Master module fail, allowing the chiller system to remain operating

.17 **Interface Panel:** A smart operator. 7" touch screen interface panel with graphical display shall be installed on the master module to allow operation and alarm monitoring, adjustment of user set points, and controlled temperatures trending.

.18 **Disconnect Switch:** Unit shall be provided with a fused disconnect switch for single point power, rated at 25 kA SCCR.

## 2.2 APPROVED MANUFACTURERS

- .1 Trane
- .2 York
- .3 Daikin
- .4 Multistack

## 3 EXECUTION

### 3.1 INSTALLATION

- .1 Install in strict accordance with manufacturer's requirements, shop drawings, and contract documents.
- .2 Each Air Cooled Heat Recovery chiller module is shipped individually for field assembly. Field assembly shall consist of the following minimum steps:
  - .1 Manifold chilled fluid and condenser fluid piping with factory supplied roll grooved connections. Insulate roll grooved connections after assembly.
  - .2 Connect factory supplied power supply wiring harnesses to the load distribution panel. Install wires to the proper terminals for proper phasing. Unit is wired for A, B, C phase right to left in the load distribution panel. Each wire on the wire harness is identified as to its respective phase.
  - .3 Connect all microprocessors together to form the local communication network. Wiring must be 20-gauge minimum, single twisted pair, shielded wiring.
- .3 Install units on a flat surface level within 3.18 mm (1/8 in) and of sufficient strength to support concentrated loading with isolation spring assemblies under the units.
- .4 Install chillers on a 500 mm structural steel supports and level, as required.
- .5 Install with adequate clearance as required by code and as per manufacturer's recommendations.
- .6 Provide the services of a factory trained representative to supervise testing and start-up of chiller and ancillaries.
- .7 Measures must be taken to avoid accumulation of debris in the evaporator during initial system flushing. This can be a 30-mesh strainer placed in the supply water line just prior to the inlet of the evaporator, bypassing the evaporator, etc. Care shall be exercised when welding pipe or flanges to the evaporator to prevent any slag from entering the vessel.
- .8 Adjust and level chiller in alignment on supports.
- .9 Provide all water piping so unit and water circuits are serviceable, without having to dismantle excessive lengths of pipe.
- .10 Provide valves in water piping upstream and downstream of the evaporator water connections for isolating the shells and to balance the system.
- .11 Provide drain valves and vent cocks for each shell.
- .12 Provide strainer ahead of all pumps and automatic modulating valves.

- .13 Provide certified wiring schematics to the electrical division for the chiller, associated equipment and controls.
- .14 Provide all necessary control wiring as recommended by the manufacturer including a separate 115/60/1 power supply to the evaporator heat tracing circuit (if applicable).
- .15 Provide vapour proof flow switches in chilled piping interlocked to the control panel.
- .16 Provide all material required for a fully operational and functional chiller.
- .17 Connect to electrical service.

### 3.2 **CONNECT TO CHILLED AND HEATING GLYCOL PIPING.START-UP**

- .1 Provide all labor and materials to perform startup. Startup shall be performed by a factory-trained technician from the original equipment manufacturer (OEM). Technician shall confirm that equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty. This shall be done in strict accordance with manufacturer's specifications and requirements. Third-party service agencies are not permitted.

### 3.3 **MANUFACTURER'S FIELD SERVICES**

- .1 Includes for preventative maintenance service agreement to run concurrent to the provided warranty duration.
  - .1 A factory-trained technician from the original equipment manufacturer (OEM) shall perform quarterly on-site operating inspections to confirm the chiller's operational performance. The manufacturer shall provide the owner with a report describing the condition of the equipment, current operating log, any issues found needing to be addressed, and recommended corrective actions.

**END OF SECTION 23 62 16**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME BPVC, Boiler & Pressure Vessel Code.
- .2 National Building Code (NBC)

1.2 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Provide the manufacturer's printed product literature and datasheets for expansion tanks and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 70 00 – Execution and Closeout Requirements.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 BUFFER TANK

- .1 Application
  - .1 For use in closed heating and chilled glycol hydronic system which have insufficient water volume to maintain optimum operating temperature control.
  - .2 Heating and chilled glycol buffer tanks shall be outfitted with 2 or 4 port connections.
  - .3 Furnish and install, as shown on plans, a buffer tank of 120 Gallons capacity.
- .2 Construction
  - .1 Shell: High strength carbon steel shell complete.
  - .2 System Connections: Female NPT, ANSI Flanges, or Grooved Pipe End connections.
  - .3 Finish: Red Oxide Primer, Enamel Paint, or Epoxy Paint.
  - .4 The tank shall be fitted with lifting rings and a floor mounted skirt for vertical installations.
  - .5 The tank must be constructed in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.
- .3 Performance
  - .1 Max. Operating Temperature: 450° F (232° C)
  - .2 Max. Working Pressure: 125 PSIG (8.55 bar)



- .4 Acceptable Manufacturers
  - .1 Amtrol Inc.
  - .2 Wessels Company.
  - .3 Watts Industries (Canada) Inc.
  - .4 Bell & Gossett Inc. (Xylem Inc.)
  - .5 Armstrong Fluid Technology Ltd.
  - .6 Taco
  - .7 Calefactio

### 3 EXECUTION

#### 3.1 INSTALLATION OF BUFFER TANK

- .1 Provide buffer tank on the suction side of circulator as shown on the Drawings and Schematics. Connect each tank with system piping as indicated on the Drawings.
- .2 Install a shut-off valve on inlet and outlet of the buffer tank; install a strainer on the outlet of the buffer tank.
- .3 Secure each tank stand to a concrete housekeeping pad by means of machine bolts. Provide a drain valve and extend a drain line from each tank and terminate each drain line to nearest floor drain.
- .4 Follow all manufacturer recommendations.

**END OF SECTION 23 71 13**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American Bearing Manufacturers Association (ABMA)
  - .1 ABMA L-10, Bearing Life Standard.
- .2 Air-Conditioning, Heating and Refrigeration Institute (AHRI)
  - .1 AHRI 410 Forced-Circulation Air-Cooling and Air-Heating Coils.
- .3 American National Standards Institute (ANSI)/Air Movement and Control Association (AMCA)
  - .1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
  - .2 AMCA 211, Certified Ratings Program - Product Rating Manual for Fan Air Performance.
  - .3 ANSI/AMCA 300, Reverberant Room Method for Sound Testing of Fans.
  - .4 AMCA 303, Application of Sound Power Level Ratings for Fans.
  - .5 AMCA 99-2408, Operating Limits For Centrifugal Fans.
  - .6 AMCA 500-L, Laboratory Methods of Testing Louvers for Rating.
- .4 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 52.1, Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
  - .2 ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
  - .3 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers.
- .5 ASTM International Inc.
  - .1 ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .6 California Division of Occupational Safety and Health (CAL-OSHA)
- .7 Canadian Standards Association (CSA International)
  - .1 CSA B51, Boiler, pressure vessel, and pressure piping code.
  - .2 CAN/CSA Standard B149.1, Natural Gas and Propane Installation Code.
  - .3 CSA C22.1, Canadian Electrical Code, Part 1.
  - .4 CAN/CSA C22.2 No. 4, Enclosed and Dead-Front Switches.
  - .5 CSA C22.2 No. 155-M, Electric Duct Heater.
  - .6 Can/CSA G40.20-13/G40.21, General requirements for rolled or welded structural quality steel / Structural quality steel.
  - .7 CAN/CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.
- .8 ETL
- .9 ISO-9001 Quality Management Systems – Requirements.
- .10 National Electrical Code (NEC) Standards
- .11 National Fire Protection Association (NFPA)

- .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .12 Sheet Metal & Air Conditioning Contractors' National Association (SMACNA)
  - .1 HVAC Air Duct Leakage Test Manual Second Edition – 2012
- .13 Under Writers Laboratories of Canada (ULC)
  - .1 CAN/ULC S110-M, Standard Methods of Test for Air Ducts.

## 1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop drawings: Submit complete material, construction and performance shop drawings for air handling units. Include the following:
  - .1 Sound analysis consisting of inlet, outlet and radiated sound power levels per unit performed by an AMCA 300 accredited lab;
  - .2 Shipping and operating weight of unit and/or sections;
  - .3 Materials of construction;
  - .4 Certified fan performance curves;
  - .5 Certified sound power data which conforms to specified levels;
  - .6 Cross section details of typical wall, floor and roof construction;
  - .7 Component equipment data as detailed in component specification section;
  - .8 Unit performance data;
  - .9 Details of coil support in a coil bank;
  - .10 Piping connection sizes and approximate locations;
  - .11 Door and window sizes and elevations;
  - .12 Drain pan details and corridor/ other section drain connections;
  - .13 All components provided with the unit;
  - .14 Operating and Maintenance Data;
  - .15 Dimensioned layout, including dimensioned (horizontal or sloped roof) curb layout and details (horizontal or sloped roof); and
  - .16 Manufacture's written declaration of unit and components design pertaining to unit construction in compliance with Post Disaster facility requirements.
- .3 Start-up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements specified in Section 01 91 00 – Commissioning Procedures and Section 20 05 93 – Testing, Adjusting, and Balancing (TAB).
- .4 Test Data: Submit factory QA/QC inspection reports verifying the integrity of gasketing, caulking, access doors, and fasteners prior to shipment. Site leakage performance test data.
- .5 Colour Chart: Submit a colour chart to indicate the standard colour range of the manufacturer of the paint finish proposed for use.

## 1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

## 2 PRODUCTS

### 2.1 DESCRIPTION

- .1 Provide custom made air handling units as indicated and in compliance with Contract Documents.
- .2 All units must be designed to the latest building codes for wind and snow loading and post disaster buildings requirements.
- .3 Specific requirements, in addition to requirements of Drawing details are as follows:
  - .1 Adhesive backed aluminum duct tape is to be applied to all metal joints in floor panels prior to erection of walls.
  - .2 All interior panels are to be smooth, and all joints are to be neatly caulked.
  - .3 All shipping sections are to be properly sealed and prepared for shipping, and are to be complete with lifting lugs, shrink wrapped openings to prevent entry of dirt, dust and debris, rigging instructions, and all gasketing, caulking and fasteners required for site connections.
  - .4 Units to be supplied in sections as required to fit through building openings.
  - .5 All section-to-section connection brackets are to be heavy-gauge galvanized steel with heavy-duty non-corrosive hardware, designed for tight section-to-section connections.
  - .6 Bases are to be welded structural steel bases, insulated, equipped with galvanized sheet metal closure for the base insulation, reinforcing cross-members as required, and lifting lugs.
  - .7 Floor duct connections are to consist of a floor opening reinforced and framed on the underside of the floor with welded structural steel angles, a No. 16 gauge, G90 galvanized steel (unless otherwise specified) flanged duct connection collar welded or screwed in place and terminated with the flange above the floor of the section, and framed, removable, hot-dipped galvanized floor grating Fisher and Ludlow "Flowforge" forge welded steel grating with perimeter hold-down clips or approved equivalent.
  - .8 Piping penetrations through casings are to be neatly and accurately cut, sealed with synthetic rubber type grommets by Kennard Ind. Inc., St. Louis, Mo. U.S.A. or approved equivalent or tight-fitting galvanized steel or aluminum escutcheon plates on both sides of the casing wall, and equipped with temporary caps.
  - .9 Provide a minimum 300 mm (12 inch) square No. 12 gauge stainless steel as a backup plate to support each light fixture, outlet box, receptacle, switch, and secure in place with sheet metal screws with exact locations to be confirmed prior to installation.
  - .10 All floor openings shall be provided with a noncorrosive safety walk over grating.

### 2.2 AIR HANDLING UNITS

- .1 General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, dampers, plenums, filters, humidifiers, drip pans, mixing dampers and other accessories as indicated on drawings or schedules.
- .2 Specific Configuration Requirements: Refer to the Drawings, which indicate the desired arrangements of the units including dimensions, orientations of units, and locations of S/A and R/A roof openings and intake and exhaust louvres. Note that the basis-of-design units are configured to fit within the space, any deviations in these dimensions.

- .3 All motor and electrical components shall comply with the requirements listed in Section 20 05 00 – General Mechanical Requirements.
- .4 All fans (and/or fan arrays) shall be provided with a variable frequency drive (VFD). Refer to Section 20 08 00 – Variable Frequency Drives (VFDs).
- .5 This specification covers the performance requirements and the material/construction requirements of custom-built air handling units. The detailed performance and data sheets and/or equipment schedule drawing(s) are considered part of this specification.
- .6 Warranty: The manufacturer shall provide the parts warranty for equipment manufactured and all vendor supplied components. The said warranty shall cover replacement of all defective parts for a period of 12 months from equipment start up.
- .7 Design Considerations:
  - .1 Manufacturers must guarantee submitted AHU performance for flow, pressure, and acoustics at the perimeter boundary of the unit.
  - .2 Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the Owner to meet the specified performance criteria.
  - .3 Coils shall be arranged so that space between coils is a minimum of 24", unless specifically shown otherwise on drawings. Coil assembly shall have provisions to facilitate total or partial removal from coil bank.
  - .4 Fan compartment shall be arranged such that the space between the fan inlet(s) and the housing is a minimum of 75% of fan diameter, unless noted or shown otherwise on the schedule or drawings.
  - .5 Housing shall be designed and sealed to minimize air and water vapor leakage. Housing shall be designed and tested for:
    - .1 Static pressures up to +/- 8" W.C. while maintaining 1.0% leakage for units:
      - .1 HRU-1
      - .2 RTU-1
    - .2 And/or shall meet maximum leakage of SMACNA Class 3 when tested in accordance with the procedure outlined in the SMACNA HVAC Air Duct Leakage Test Manual Second Edition – 2012
- .8 Approved manufacturers:
  - .1 Trane
  - .2 Engineered Air
  - .3 Haakon
  - .4 Mafna
  - .5 Ventrol (EFI Concepts)
  - .6 Scott Springfield
  - .7 York (Johnson Controls)
  - .8 Aeon

## 2.3 UNIT CONSTRUCTION

- .1 CONSTRUCTION

- .1 Unit casing shall be of minimum 1.6mm (16 ga.) satin coat galvanized steel sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.
- .2 The following components shall be provided with a 0.85mm (22 ga.) solid/ perforated (40% free area) galvanized metal liner or 0.85mm (22 ga.) 304 SS for corrosive or hazardous environments (e.g humidifier section, exhaust air path from locker/ shower areas, exhaust air path from hazardous areas) over insulated areas:

	Solid Liner	Perforated Liner
- Fan Sections		X
- Mixing Sections		X
- Coil Sections	X	
- Filter Sections		X
- Access Sections	X	
- Humidifier Sections	X	
- Underside of Unit	X	

- .3 All high pressure [1250Pa (5" w.c.) to 2250Pa (9" w.c.)] fan sections shall be constructed of 2.0mm (14 gauge) galvanized steel sheet metal. Continuous high-pressure sealant shall be provided between all panels.
- .4 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor unit roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant.
- .5 All units shall be internally insulated with 51mm (2") thick nominal 48 kg./cu.m. (3 lb./cu.ft.) density acoustic insulation.
- .6 48 kg/cu.m. (3 lb./cu.ft.) insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.
- .7 Unit casing floors and all in walk in sections shall be fabricated with reinforced, minimum 3mm (0.125 in) aluminum checker plate. Provide 40 mm (1 ½ in) watertight collars around inside of perimeter of unit and around floor openings. Provide drain connections.
- .8 Provide reinforcing channels under floor to minimize deflection.
- .9 Cooling coil drain pans shall be fabricated of double sloped stainless steel and are an integral part of the floor paneling, a minimum of 51mm (2") deep, with welded corners. Drain pans shall extend a minimum of 152mm (6") downstream of coil face and be provided with a 38mm (1 ½") S.S. M.P.T. drain connection. Drain pans must have a fast pan and be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.
- .10 Provide stainless steel (extended) drain pan in humidifier section.
- .11 In heat reclaim units, the exhaust section drain pans shall be an integral part of the floor paneling, a minimum of 51 mm (2") deep, with welded corners. Drain pans shall extend over the full exhaust fan plenum and be connected with a 38 mm (1 ½") M.P.T. drain connection.

## .2 OUTDOOR UNITS

- .1 Where scheduled/indicated, air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of

rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 25mm (1") galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 51mm (2") with three break interlocking design; outer wall panels extend a minimum of 6mm (¼") below the floor panel; drain trap(s) connections for field supply and installation of drain traps.

- .2 Where scheduled/indicated, provide full perimeter seismic roof mounting curb of heavy gauge sheet metal, minimum of 18" (457 mm) high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25mm) upturn on inner perimeter, to provide a complete seal against the elements and seismic restraints. External insulation and flashing of the roof-mounting curb shall be provided by the Roofing Contractor.
- .3 Air handling units mounted on roof curbs shall incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.
- .4 Where specified/indicated a service corridor shall be provided. All aspects of the service corridor construction shall match the air handling unit that it's associated with.
- .5 Casing shall be primed with etch bond epoxy and painted with two coats of polyurethane paint minimum 3 mils. Paint finish on outdoor units to be capable of withstanding US Federal Test Standard No. 141 (Method 6061) 500 hour salt spray test.
- .6 Exterior doors in units to be fitted with lockable door hardware.

## 2.4 ACCESS DOORS AND PANELS

- .1 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums and humidifiers/wet cells, electrical control panels, coil compartments, and heat recovery. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
- .2 Access doors shall be double wall construction complete with an extruded aluminum frame. The door frame shall feature a built-in no-through-metal high density resin barrier and a full perimeter gasket. Door frames with no thermal break are not acceptable. The door gasket is seamed together at each corner to prevent leakage through the door. Door is attached to the unit with 3 axes adjustable stainless-steel hinges.
- .3 Doors shall be provided with a minimum of two lever handles, operable from both sides for all units
- .4 Doors shall open against higher pressure side. Where this is not feasible due to site constraints, an interlocking mechanism furnished on the fan section access door with a de-energizing switch complying with CAL-OSHA, ETL and the mechanical protection requirements of UL 1995 will be provided. All outward swinging doors must be equipped with a door chain to limit door swing.
- .5 Doors shall be provided with dual-paned tempered glass with vacuum seal windows, molecular sieve sealant and thermally broken frames shall be supplied as shown on unit drawings. Singled paned windows are not acceptable.
- .6 Minimum size:
  - .1 door height: minimum 1500 mm (60 in) or 200 mm (8 in.) less than inside height of unit
  - .2 door width:
    - .1 minimum 600 mm (24 in.) for doors that require personnel access, and

- .2 minimum 450 mm (18 in.) for doors that do not require personnel access to repair/remove parts (eg. Side loaded filter sections, drainage pan cleaning, etc.) fan section doors to be sized to permit fan and motor removal

## 2.5 PLENUM FAN

- .1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.
- .2 All fans shall be plenum type configuration Airfoil and BI fans. Thrust restraint isolators shall be provided parallel to the shaft centerline when required to minimize axial movement and bending movements of the blower assembly(s). Drive side bearings on plenum fans shall be adapter style to ensure even clamping of the bearing sleeve to the shaft.
- .3 Airfoil and/or BI fans shall be equipped with greaseable, self-aligning ball or roller type pillow block bearings.
- .4 Provide CSA approved epoxy coated galvanized steel inlet screen, and galvanized steel open wire mesh protective discharge screen. Removable screens at access doors are not acceptable.
- .5 Drives shall be adjustable on fans with motors 7 1/2 HP (5.6 kW) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
- .6 Provide full section plenum return air fan(s) as scheduled. The use of other fan arrangements will not be considered.
- .7 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.
- .8 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 230 mm (9") to 380 mm (15") diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 25mm (1") static deflection designed to achieve high isolation efficiency. Provide seismic restraint type isolators containing compressed spring, and/ or neoprene-in shear. Use of separate bumper or snubber is not acceptable.
- .9 Flexible Connection: Waterproof indoor-outdoor woven fiberglass fabric coated on both sides with a specially compounded synthetic rubber, flexible material between the fan intake and/ or discharge and the casing opening, with spring thrust restraints secured to welded brackets on the fan housing and by steel rods through the fan casing with a steel back-up plate.
- .10 Provide single extended grease line from far side to access side bearing.
- .11 Finish: Unless otherwise specified, rust inhibiting primer applied to cleaned and deburred surfaces prior to assembly, then a second coat of the primer after assembly and a group 3E air dried epoxy coated finish completely inside and outside 3 mill thickness.
- .12 Variable Fan Speed Controls:
  - .1 Provide variable air volume fan control for fans via Variable Frequency Drive.
  - .2 Minimum CFM of 30% unless otherwise directed by fan motor manufacturer.
  - .3 Variable frequency drive serving the fan shall be located within a temperature-controlled cabinet to ensure the ambient temperature requirements are met.



- .4 Drives within electrical cabinet shall still be provided with a NEMA 1 enclosure and shall be labeled by an approved testing agency such as cUL. Otherwise, indoor NEMA 4, outdoor NEMA 4x.

## 2.6 COILS

- .1 AHRI Standard 410 rated and certified drainable coils designed and constructed to meet requirements of the CSA B-51 Code Category "H" as a registered fitting and complete with a Canada Wide CRN.
- .2 A 304 stainless steel coil slide-in, slide-out mounting framework within the coil section
- .3 Coils shall not exceed 15 kPa (5 feet) WPD and 62 Pa (0.25 inch) APD.
- .4 Chilled or Hot Water Coils
  - .1 Primary Tube Surface:
    - .1 Round seamless 15.9 mm (5/8") O.D. copper tubes with 0.5 mm (0.020") wall thickness mechanically expanded into fin collars of the secondary surface. Tubes shall be mechanically expanded to provide a permanent metal-to-metal bond for efficient heat transfer. Manufacturer may only use staggered tubes in direction of airflow and only return bends - reduced tube wall hairpin bends are not acceptable. 10 rows maximum.
  - .2 Secondary Fin Surface:
    - .1 Die-formed, corrugated plate-type 0.2 mm (0.008") Aluminum fins with full drawing fin collars to provide accurate fin spacing control and maximum tube contact. 12 fins per inch maximum.
  - .3 Headers:
    - .1 Seamless copper with die-formed holes to provide a parallel surface to the coil tube for strong brazing joints. Coil is supplied with 3.2 mm (1/8") brass female pipe thread (FPT) vents and drains. All circuiting is designed to gravity-drain.
    - .2 Headers shall be internal to the air-handling unit. The non-headered end of the coil shall be fully concealed.
  - .4 Connections:
    - .1 Red Brass Schedule 40 male pipe thread (MPT) to prevent dielectric reaction between dissimilar metals.
    - .2 Factory installed in accordance with the Drawing piping schematic using pipe, fittings, couplings, valves, and accessories as specified in heat transfer piping Sections of the Specification, and with capped piping terminated as indicated for site connections. Staggered coils are to be factory piped to the outside face of the casing
  - .5 Casing:
    - .1 Minimum 1.6mm (16 gauge) G-90 galvanized steel (heating coils), 304 stainless steel (cooling coils), with 38 mm (1-1/2") die-formed flanges to permit easy stacking and mounting. Intermediate tube supports are supplied on coils over 1100 mm (44") fin length with additional supports every 1050 mm (42") multiple thereafter.
  - .6 Testing and Performance:
    - .1 All coil assemblies are leak tested under water at 2415 kPa (350 PSIG). Standard construction is suitable for 250 PSIG operating pressure up to 149°C (300°F). Performance shall be certified under AHRI Standard 410.

All coil performance ratings are generated with manufacturer's AHRI certified selection software.

## 2.7 FILTERS, FILTER FRAMES, AND FILTER BANKS

- .1 Pre-filters:
  - .1 The filter shall consist of a pleated media, media support grid, and enclosing frame. The media shall be non-woven cotton fabric and shall be designed to consistently increase efficiency throughout service life of filter with an initial MERV 8 rating.
  - .2 The media support shall be a welded wire grid with an effective open area of not less than 90%. The grid shall be bonded to the filter media to eliminate media oscillation and pull away. The enclosing frame shall be constructed of rigid, heavy duty, high wet strength beverage board. The frame shall be bonded to the filter pack.
  - .3 Standard sizes shall be 300mm x 600mm x 50mm (12" x 24" x 2") and 600mm x 600mm x 50mm (24" x 24" x 2"). All filter holding frames must be caulked in between them to minimize bypass air through the frames.
  - .4 Filters shall be American Air Filter Perfect Pleat, or equal by Cam-Farr, Eco-Air, Airguard, Koch, or Daeco. Provide Dwyer Instruments Inc Series 2000 Magnehelic gauges across each filter bank.
- .2 Final Filter – Rigid Type
  - .1 The filter shall be a high performance, deep pleated, totally rigid type and shall consist of a glass fiber media, media support frame, contour stabilizers, and enclosing frame. The filter media shall be a high density microfine glass fiber laminated to a non-woven synthetic backing to form a lofted filter blanket.
  - .2 The media shall provide superior dust holding, moisture resistance and overall performance with an initial MERV 16 rating as further specified in the Schedules. The media support shall be a welded wire grid with an effective open area of not less than 96%. The grid shall be bonded to the filter media to eliminate media oscillation and pull-away. The grid shall support the media both vertically and horizontally. Contour stabilizers shall be permanently installed on both the air entering and exiting sides of the filter media pack to ensure the pleat configuration is maintained throughout the life of the filter. The enclosing frame shall be constructed of galvanized steel. It shall be constructed and assembled to provide a rigid and durable enclosure for the filter pack. The frame shall be bonded to the filter pack.
  - .3 Standard filter sizes shall be 300mm x 600mm x 300mm (12" x 24" x 12") and 600mm x 600mm x 300mm (24" x 24" x 12"). All filter holding frames must be caulked in between them to minimize bypass air through the frames.
  - .4 Filters shall be American Air Filter Rigidil, or equal by Cam-Farr, Eco-Air, Airguard, Koch, or Daeco. Provide Dwyer Instruments Inc Series 2000 Magnehelic gauges across each filter bank.
- .3 Carbon Activated Filter – Provided and stored on site, to be installed based on BAS air quality alarms.
  - .1 Standard filter sizes shall be 300mm x 600mm x 300mm (12" x 24" x 12") and 600mm x 600mm x 300mm (24" x 24" x 12"). All filter holding frames must be caulked in between them to minimize bypass air through the frames.
- .4 Filter Gauge
- .5 Unless otherwise specified, Dwyer Series DM-2007-LCD Differential Pressure Transmitter, one for each pre-filter bank, activated carbon filter and one for each final filter bank. Provide 4-20 MA output for monitoring by the BAS Filter Frame Assembly

- .1 Constructed of galvanized steel, specifically designed and sized to have matching mounting holes such that frames may be riveted together. Frame shall come with pre-installed gasket so as to provide a surface onto which the filter will self-seal.
- .2 Filter frames come with stiffeners which are installed between each column of filter frame. All filter holding frames are caulked in between them to minimize bypass air through the frames. Proper structural support (every 5 frames wide) shall be provided when reinforcement is required for attachment of frame assembly to existing AHU casing / building structure as well as complete safing and proper air seal, blank-off sheets as required to prevent air by-pass, and stainless steel wire grid members to prevent dirty filters from being sucked out of the filter rack.
- .3 Filter frame assemblies shall be provided for the pre-filters, final filters, as well as optional carbon filters.

## 2.8 DAMPERS

- .1 Dampers shall be low leakage aluminum dampers made of extruded aluminum airfoil blades with extruded EPDM blade gaskets and extruded TPE frame seals, 7/16" aluminum hexagon shaft, aluminum linkage crankarm, aluminum pivot pin, acetal copolymer inner bearing and polycarbonate outer, and a 12-ga. aluminum frame. Manufacturer shall be TAMCO 1500 (standard), TAMCO 9000 (insulated), Ruskin CD-50 (standard), Ruskin CDTI-50 (insulated), or equivalent.
- .2 Two position inlet dampers and mixing dampers shall be parallel blade type.

## 2.9 LOUVERS

- .1 Furnish and install louvers as herein after specified where shown on plans. Louvers shall possess stationary blades designed to prevent the penetration of wind driven rain. Louver blades shall be contained within a 75 mm (3") frame. Extended sill shall be provided to capture and drain water to exterior of air handling unit. Louver components shall be assembled by the louver manufacturer. Louver design shall limit single section sizes to 1200 mm x 2400 mm (48" x 96") and shall withstand a wind load of 958 Pa (20 lbs/ft<sup>2</sup>) [equivalent to a 144 kph (90 mph) wind]. Manufacturer shall be Ruskin, Model # EME3625, or equivalent.
- .2 Bottom edge of louvred opening at least 1.2 m (4 ft) above roof.
- .3 Construction
  - .1 Frame: Extruded aluminum alloy 6063-T5 with nominal wall thickness of 1.6 mm (0.062") and 75 mm (3") deep
  - .2 Blade: Extruded aluminum alloy 6063-T5 vertically mounted with nominal wall Thickness of 1 mm (0.040") spaced 19 mm (0.75") center to center.
  - .3 Bird Screen: Aluminum, 13mm (1/2") x 40 mm<sup>2</sup> (0.063 in<sup>2</sup>) mesh in a removable frame.
  - .4 Sill flashing is formed aluminum, 2mm (0.081") with end dams.
  - .5 All louver components shall be factory assembled.
  - .6 Louvers shall be tested in accordance with AMCA 500-L Wind Driven Rain Test.

## 2.10 AIR INTAKE COWLS/ HOODS

- .1 Furnish and install multi sectioned, structurally reinforced:
  - .1 Fabricated from 1.6 mm (16 ga) galvanized steel, cross broken for rigidity, and
  - .2 Finished with formed perimeter drip gutter,
  - .3 Bottom edge of intake opening at least (1.2 m (4 ft) above roof,

- .4 Fitted with galvanized steel wire mesh birdscreen with 12x12 mm ( $\frac{1}{2} \times \frac{1}{2}$  in) openings, fastened to 1.6 mm (16 ga) galvanized reinforcing framing with cadmium plated screws.
- .5 Provide spool piece to allow outdoor air flow station installation.

## 2.11 HEAT RECOVERY

### .1 HEAT WHEEL

#### .1 General Specifications:

- .1 Furnish and install an energy recovery wheel, as shown in the Air Handling Unit Schedule.
- .2 The energy recovery wheel shall transfer both sensible and latent energies between outgoing and incoming air streams in a counter flow arrangement.
- .3 The energy recovery wheel shall be labeled for direction of air flow, exhaust and supply inlets and outlets.
- .4 The energy recovery wheel manufacturer must have at least ten (10) years of experience in the manufacturing of energy recovery components and be ARI certified.

#### .2 Product Specifications:

##### .1 Media

- .1 The rotor media shall be made of aluminum.
- .2 All surfaces shall be coated with a non-migrating desiccant specifically developed for the water vapor transfer. Maximum molecular sieve size shall be 3Å. Desiccant coating is not required for sensible heat recovery wheels.
- .3 Etched or oxidized surfaces are not acceptable.
- .4 Desiccant must be a polymer hygroscopic coating.
- .5 Desiccant shall be bactericide and non-corrosive.

##### .2 Purge & Casing Assembly

- .1 The unit shall be provided with a factory set, but field adjustable, purge section designed to limit cross contamination when operated under appropriate design conditions.
- .2 The rotor shall be provided with a structural frame which limits the deflection of the rotor due to air pressure differential to less than 1/16 of an inch.
- .3 The framing shall be made of heavy-duty steel construction.
- .4 Framing shall be painted.
- .5 The cassette shall be mounted with removable cover panels for service access to the motor and drive.
- .6 The rotor shall be supported by two pillow block bearings which can be maintained or replaced without removal of the rotor from its casing or the media from its spoke system.

##### .3 Rotor seals

- .1 The rotor shall be supplied with non-contact labyrinth seals facing the media and with nylon contact seals on all other surfaces.

- .2 The seals shall be specifically designed to compensate for pressure fluctuations.
      - .3 The seals shall be adjustable to ensure proper sealing.
    - .4 Rotor frame system
      - .1 The rotor shall be driven by a high-performance link belt made of polyurethane elastomer reinforced with polyester for easier installation and replacement.
      - .2 An A/C inverter duty motor shall drive the rotor.
      - .3 Wheel shall be perimeter driven.
      - .4 Speed reduction is done by controlling the motor frequency through a variable speed drive.
    - .5 BAS Interface
      - .1 Provide BAS interface. Refer to control drawings and sequence of operation for additional details/ requirements
- .2 HEAT PIPE
  - .1 General Specifications
    - .1 Furnish and install heat recovery units of the heat pipe air-to-air type, as shown in the Air Handling Unit Schedule.
    - .2 Performance data derived from laboratory testing on heat exchanger conditions shall be in accordance with ASHRAE Standard 84-1991 "method of testing air-to-air heat exchangers".
    - .3 The manufacturer must be ISO-9001 certified to ensure a quality management system which includes the design, manufacture and service of its energy recovery components.
  - .2 Product Specifications
    - .1 The heat exchanger core shall be of 5/8" or 1" seamless aluminum tubing permanently expanded into aluminum fins. Each tube shall be an individually sealed heat pipe filled with a working fluid conforming to Group 1 in the American National Standard Safety Code for Mechanical Refrigeration. Serpentine coils or headered tubes will not be considered equal and shall be bid as an alternate.
    - .2 The secondary surface shall be continuous plate aluminum fins of corrugated design to produce maximum heat transfer efficiency and reduce the frost threshold of the unit.
    - .3 Heat pipe tubes must be wicked. The capillary wick of each heat pipe shall be an integral part of the inner wall of the tube to provide a completely wetted surface for maximum heat pipe capacity with minimum heat transfer resistance. Non wicked heat pipes will not be considered as an equal, unless they have a minimum of 20% additional rows, and are increased in face area to provide a pressure drop equal to or less than that specified for the QDT heat pipes.
  - .3 Dewpoint Control: Where scheduled the heat pipe shall be provided in "Wrap Around" configuration to provide pre-cooling and post reheat. The cooling coil (installed between the "wrap around evaporator and condenser) shall be controlled to meet the space dewpoint requirements
- .3 MULTI SECTION UNITS

- .1 Arrange with installation trades for multi section units where limited site access or other restrictions prevent installation and/or shipping of unit's factory assembled.
- .2 Prepare manufacturing and assembly drawings and identify sub-assemblies, parts shipped loose and assembly materials including insulation, sealants, fasteners and hardware.
- .3 Prepare sequence of assembly showing hoisting, placing and fastening procedures.
- .4 Obtain agreement from installing trades before proceeding to manufacture.
- .5 For testing, factory assemble and test unit, disassemble components and ship in pieces once satisfactory leakage, flow testing, electrical testing is complete.
- .6 Pretest electrical components, conduit, and wiring in each section at the factory.

**2.12 CONTROL PANEL:**

- .1 All hydronic air handlers will be provided by with a field mounted control panel supplied and installed by the Division 25 Contractor.
- .2 Refer to sub-section "Electrical" of this specification for power connections.
- .3 Provide BAS interface. Refer to control drawings and sequence of operation for additional details/ requirements

**2.13 CONTROLS:**

- .1 It is the intent of this Section that the Control contractor gives the Air Handling Unit Manufacturer all control components which are required to be installed within the Air Handling Unit.
- .2 The Air Handling Unit manufacturer installs all control devices, conduit, and specified wiring (control and power) required on or within the unit except for unit power supply connections which are the responsibility of Division 26.
- .3 Flow sensors and transmitters are provided by Section 25 00 00, sensors are installed in fan inlets by this Section. Tubing between flow sensors and transmitters (mounted at VFD panels) is the responsibility of this Section.
- .4 The control contractor supervises the installation of all control components within the Air Handling Units.
- .5 Refer to HVAC control drawings, particularly the drawing notes, for a description of the controls related items that this Section is responsible for.
- .6 Mount all safety shutdowns (e.g. freezestats) and provide wiring to a common terminal strip for wiring back to the control panel provided by Section 25 00 00.

**2.14 ELECTRICAL**

- .1 Each air handler shall be provided with a single point 575V connection serving all motors and VFDs (supply fan, exhaust fan, heat wheel).
- .2 Separate 120V connection(s) shall be provided for each air handling unit serving all lighting and control devices.
- .3 Each air handler shall be provided with HVAC control interface panel.
- .4 Unit control system located in sheet metal weatherproof enclosure. If enclosure is provided outdoors, provide thermostatic heater to prevent condensation and corrosion.
- .5 Provide circuit protection for all electrical components.
- .6 Provide all necessary distribution panels and transformers.

- .7 Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements.
- .8 Each fan motor shall be individually wired to a motor control panel containing motor overloads and Variable Frequency Drives (VFD). VFD configuration shall be as described in the Air Handling Unit Schedule, Heat Recovery Unit Schedule, Energy Ventilator Schedule or in control sequence of operation.
- .9 Units s equipped with vapor proof light fixture(s) with guard. Unit drawing's fixture locations are approximate. Lights shall be controlled by one switch, or each light will have its own switch. Refer to unit plans for details. Conduit for lights and outlets shall be electrical metallic tube (EMT). Flexible conduit connections shall be liquid tight. All junction boxes shall be gasketed.
- .10 AHU tag must bear the ETL label.
- .11 Receptacles: Cooper Wiring Devices #5262V or approved equivalent, CSA certified, heavy duty, ivory, 15 ampere, 125 volt, 2 pole, 3 wire, U-ground duplex receptacles, each complete with a Cooper Wiring Devices #WLRD-1, 2-gang weatherproof aluminum snap cover.
- .12 Disconnect Switches: Cooper Crouse-Hinds #NRS Series or approved equivalent, non-metallic, heavy-duty, front operated, quick make and break door interlock safety switches in accordance with CSA Standard C22.2 No. 4 and complete with NEMA 4X enclosure.
- .13 Switches: Hubbell Canada Inc. #1297 or approved equivalent single pole, CSA certified, 15 ampere, 120 volt "presSwitch" with red nylon actuator and 120 volt pilot light, and #1795 "presSwitch" clear bubble silicon rubber coverplate. Unless otherwise as shown or specified, connect all air handling unit lighting fixtures to one switch and all service corridor lighting fixtures to one switch.
- .14 Marine Lights:
  - .1 Installed In each section of indoor and outdoor unit provided with access door and/ or service corridor.
  - .2 Fluorescent surface mounting vapour-proof marine lights with solid state electronic ballast (-25 degrees C) (13 degrees F), CSA certified, aluminum construction with an epoxy finish, heat resistant glass globe and guard and 18 watt compact fluorescent lamp.
  - .3 On outdoor unit at corridor entrance provide outdoor fixtures complete with motion activated fixture with 3 heads, 120 Volt, adjustable photo control motion sensor.
  - .4 Provide one replacement (extra) lamp per fixture
- .15 Factory Wiring: Factory installed CSA certified wiring is to include:
  - .1 Marine lighting fixtures located where shown, each secured to a cast aluminum surface mounted box.
  - .2 A switch located where indicated, connected with "load" side wiring to control all lighting fixtures.
  - .3 Wire electric heating coil and motor to a common point.
  - .4 Provide single point power connection for 575/3/60.
  - .5 Provide single point power connection for 120/1/60 (lights and receptacles).
  - .6 Provide single point power connection for the SACs (DDC control cabinets) 120/1/60.
  - .7 Air handling unit(s) are to be prewired and suitable for single 575 Volt incoming supply and two 120 Volt supplies (one for AHU lights and receptacles and one for the BAS controller).

- .8 Receptacles in Crouse-Hinds or approved equivalent, CSA listed Condulet cast 316 stainless steel boxes located in corridor spaces on air handling unit casings approximately 450 mm (18 inches) above the floor at 4.5 m (15 feet) centre-to-centre spacing with a minimum of two receptacles per corridor, connected two receptacles per circuit with wiring terminated in a cast aluminum junction box with cover.
- .9 A disconnect switch for each motor, located at the strike side of the access door into the section where the motor is located, connected with "load" side wiring to the motor, and equipped with an engraved white letters-black background laminated plastic nameplate to identify the motor, i.e. "FAN AHU-1".
- .10 A disconnect switch for lights and receptacles.
- .11 Wiring from VFD(s) to motor(s) shall be suitable for VFD applications, inclusive of grounding, shielding, and electrical insulation. The cable shall be capable of withstanding the most severe conditions (environmental, mechanical, and electrical) likely to be encountered in service. The insulating materials used shall consider the risk of fire or electrical shock under the conditions of intended use.
- .12 Provide all power and control wiring to control devices in rigidly secured surface mounted cUL listed threaded rigid 304 stainless steel EMT conduit including flexible liquid-tight conduit at motor connections. Galvanized steel EMT conduit is an acceptable alternative for sections with a galvanized steel interior liner, refer to clause 2.3.A.2 of this specification for liner requirements.
- .13 Provide starter for each motor (if VFD not provided)
- .14 A 300 amp, 600 volt breaker in a NEMA 4 enclosure. Division 26 is to provide 575 volt 3-phase power to this disconnect switch. All other wiring in the Air Handling Unit(s) is to be pre-wired by the factory.
- .15 Provide all power and control wiring to control devices in rigidly secured surface mounted cUL listed threaded rigid 304 stainless steel EMT conduit, including flexible liquid-tight conduit at motor connections. Galvanized steel EMT conduit is an acceptable alternative for sections with a galvanized steel interior liner, refer to clause 2.3.A.2 of this specification for liner requirements. Conduit to be as manufactured by Crouse-Hinds, Calbrite Division of Calpipe Industries Inc. or approved equivalent.
- .16 "RW90" or TWH" colour coded copper conductors and rigidly secured surface mounted PVC coated threaded rigid galvanized steel EMT conduit in accordance with wiring requirements specified in Division 26, including flexible liquid-tight conduit at motor connections
- .16 Local Equipment Panels:
  - .1 Local control panels are to be NEMA 4 enclosures with hinged latching doors. Mount pilot lights and selector switches on the front panel. CSA approval is required on the enclosure.
  - .2 Supply 120/1/60 service receptacle, 15 amp.
  - .3 Fuses on low voltage side.
  - .4 All wiring within panel to be enclosed in Panduit. All field wiring shall be terminated at a single terminal strip located on one side of the panel.
  - .5 Identify gauges and control devices on panel face with engraved lamaroid labels with engraved black letters-white background laminated plastic nameplate indicating function of instrument, factory installed. Relays and terminal blocks within panel shall be identified with plastic slip-on wire markers.
  - .6 Identify and label all components within panel.



- .7 All field control and power wiring, panel wiring, equipment terminations or field wiring joints shall be identified by tubular sleeve heat shrink-type or non-heat shrink-type markers as follows:
  - .1 Wire markers shall be white with black print.
  - .2 Properly sized as per the manufacture's recommendations for the type and size of wire/cable.
  - .3 Labeling shall agree with manufacturer's equipment drawings, control drawings and panel directories.
  - .4 Shall be CSA/ULC approved for the intended use.
  - .5 Wire markers shall be Brady "PermaSleeve" wire markers B-319 or B-321 or pre-approved equivalent.
  - .6 Handwritten or adhesive book numbers/letters shall not be acceptable.
- .8 Indicating lights on panel cover shall be minimum 20 mm (3/4-inch) diameter Allen Bradley oiltight push to test lights, with 24 VAC replaceable light bulbs.
- .9 HVAC Controller (HCP) Panels are to be provided by Section 25 00 00.
- .17 Motor Starters:
  - .1 Provide (unless VFD is provided) NEMA rated breaker type full voltage non-reversing type combination starters in a NEMA 4 enclosure for fans with following features:
    - .1 Suitable for 600 volts, 3-phase supply.
    - .2 Sized for supply and return fan motors characteristics.
    - .3 Fused oversized control transformer.
    - .4 Separate enclosure for each starter.
    - .5 Engraved lamicoid nameplate identifying load and power source.
    - .6 Provide Thermister operated relay complete with door mounted pilot light and reset button. Ensure that reset is not required when incoming power is cycled.
    - .7 Solid-state overload relay.
    - .8 Accessories: (Current sensing device with 4-20 mA output, HOA switch with auxiliary contacts, starter auxiliary contacts, timers and relays) to satisfy interlocking and automatic control requirements.
    - .9 For supply fan, provide fused power factor correction capacitor (to achieve power factor of 0.95). Capacitor is to be complete with enclosure and blown fuse indicator.
    - .10 Identified control wiring, terminal block and control devices.
    - .11 Drawing pocket.

## 2.15 FACTORY FINISH

- .1 All exterior galvanized steel surfaces are to be hand acid etched, chemically cleaned, coated with proper primer, then painted with two 100 percent covering coats of enamel. Refer to clause 2.3.B.5 of this section for paint requirements of outdoor units.
  - .1 Outdoor Units: Paint colour for outdoor units to be RAL 7047.
  - .2 Indoor Units: Paint colour for indoor units to be manufacturer's standard colour / colour range (preferably grey).

- .2 Paint (finish) louvers or hoods to match unit colour. Supply four (4) litres of touch-up paint for each unit.

### 3 EXECUTION

#### 3.1 INSTALLATION

- .1 Provide air handling units where shown.
- .2 Contractor to rig and hoist each roof mounting unit section to the roof (or inside mechanical penthouse) in accordance with the manufacturer's instructions and details and assemble in place. Unit Manufacturer or Manufacturer's Sales Representative to provide guidance during the installation and written confirmation of satisfactory installation. Give unit manufacturer or Manufacturer's Sales Representative a minimum of seven (7) working days' notice prior to commencement. Refer to Drawing details. Provide continuous compressible gasket material between the curb and the unit base. Properly and adequately protect air handling unit sections on the ground prior to hoisting.
- .3 Secure the base mounting unit(s) in place, level and plumb.
- .4 Remove fan base hold-down clamps and all other shipping restraints.
- .5 Maintain blanket type temporary filter media in the filter section until commissioning work and air quality balancing is ready to commence, at which time remove the temporary media, vacuum clean the interior of the unit, and install pre-filters and final-filters.
- .6 Provide initial installation of complete sets of pre-filters and final-filters at fan start-up for each unit and supply one complete spare set of pre-filters and one complete set of final-filters for each unit and store on site where directed. Factory-install first set of filters.
- .7 Adjust filter gauges and mark each scale with a red stick-on arrow to indicate when filter replacement is required.
- .8 Supply touch-up paint and touch-up all exterior finish damage when installation is complete. Hand the remainder of touch-up paint in an identified container(s) to the Owner on site.
- .9 When installation is complete, Manufacturer's Sales Representative is to arrange for and perform site leakage testing in accordance with requirements specified for factory leakage tests. If results of site tests indicate a higher rate of leakage than that specified, re-seal the entire unit and re-test until satisfactory results are obtained. Perform site leakage testing in accordance with requirements specified for factory leakage tests.
- .10 Start-up, test and commission each air handling units in accordance with Section 20 08 00. Supply fan equipment and technical representatives at the site to supervise start-up, testing and commissioning procedures.
- .11 Coordinate with Division 25 Contractor to provide access to all air handling units to ensure proper tie-in with BAS controllers.
- .12 Install first set of filters prior to commissioning and second set after completion of commissioning.

#### 3.2 INSTALLATION OF FIELD ASSEMBLED CUSTOM-MADE AIR HANDLING UNITS:

- .1 The air-handling unit shall be field assembled on site by the contractor. All parts shall be pre-formed by the manufacturer and partially assembled where access is possible. The parts shall be labeled according to an assembly drawing. All assembly material required such as insulation, sealants, fasteners and hardware shall be supplied by the manufacturer as part of the kit.
- .2 Where access permits, sections of the exterior casing shall be pre-assembled in the factory. Otherwise, casing panels shall be shipped individually.

- .3 The unit base shall be made in factory-assembled sections with joining flanges for field assembly. The base sections shall be pre-painted and pre-insulated in the factory.
- .4 The doors and frames shall be pre-assembled (complete with windows where specified).
- .5 Where access permits, the coil and filter racks shall be pre-assembled and pre-painted in the factory.
- .6 The fan shall be assembled in the factory complete with motor, protective screening, and isolation base. The fan and guarding shall be pre-painted in the factory. The fan assembly shall undergo a test run in the factory. Where access permits, the fan assembly shall be shipped in one piece. If access does not permit shipping in one piece, the fan shall be disassembled and shipped in pieces.
- .7 The manufacturer shall supply a representative to supervise the assembly of the air-handling unit on the jobsite.
- .8 The coils shall be installed on site by the Contractor.
- .9 The air-handling unit shall be finish-painted on site by the Contractor.
- .10 The electrical panels shall be pre-assembled and pre-tested in the factory. The manufacturer shall provide all necessary conduits and fittings to extend the motor wiring to the electrical panel.
- .11 The air-handling unit manufacturer shall provide marine light fixtures, duplex receptacles, the light switch and the necessary conduit and fittings for field installation of the fixtures.
- .12 All factory and field wiring and assembly shall be done in accordance with the CEC.
- .13 The contractor shall be responsible for obtaining electrical approval of the final assembly.

**END OF SECTION 23 72 00**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers (ANSI/ASHRAE)
  - .1 ANSI/ASHRAE 51.2-2017, Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
  - .2 ANSI/ASHRAE 52.2-2017, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size.
  - .3 ANSI/ASHRAE 127-2012, Method of Testing for Rating Computer and Data Processing Room Unitary Air-Conditioners.
- .2 Canadian Standards Association (CSA)
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/CSA C22.2 No. 248, Publication of Trinational Standards for Fuses.
- .3 Underwriters Laboratories (UL)
  - .1 UL 248-1/UL 248-14/CSA-C22.2 No. 248.1/CSA-C22.2 No. 248.14, Low-Voltage Fuses

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings: Submit complete material, construction and performance shop drawings for makeup air units. Include the following:
  - .1 Major component and accessories data.
  - .2 Dimensional data, shipping and operating weight of unit and/or sections.
  - .3 Materials of construction.
  - .4 Certified sound power data which conforms to specified levels;
  - .5 Unit performance data.
  - .6 Piping and Electrical Connection Drawings: Show connection sizes and approximate locations.
  - .7 Operating and Maintenance Data
  - .8 Single-Line Diagrams
- .4 Start-up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements specified in Section 01 91 00 – Commissioning Procedures and Section 20 05 93 – Testing, Adjusting, and Balancing for HVAC.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.

- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Store at temperatures and conditions recommended by the Manufacturer.

#### 1.4 QUALITY ASSURANCE

- .1 The specified system shall be factory-tested before shipment.
- .2 The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

### 2 PRODUCTS

#### 2.1 DESCRIPTION

- .1 System type: The CRAC system shall be self-contained, factory-assembled unit. Standard 60 Hz units shall be CSA-certified to CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment and are marked with the CSA c-us logo. Chilled glycol cooling units shall serve the IT room. The CRAC shall provide cooling to the space.
- .2 The system shall be AHRI Certified™, the trusted mark of performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, using AHRI Standard 1360.
- .3 Refer to CRAC Schedule and this Section for performance requirements.
- .4 Acceptable Manufacturers:
  - .1 Vertiv (Liebert)

#### 2.2 CABINET

- .1 The cabinet shall be designed so all components are easily accessible for service and maintenance through either the front or rear of the unit. Units that are not fully accessible from front and rear or not serviceable in place shall be unacceptable. Side access shall not be required.
- .2 600 mm (24 in.) wide units
  - .1 Exterior panels shall be 20-gauge steel and powder-coated with charcoal color paint to protect against corrosion.
  - .2 Side panels shall be double-wall separated by 12mm (1/2 in.), 2.0 lb./ft3 insulation to keep insulation out of the air stream and increase unit rigidity.
  - .3 The unit shall be mounted on casters for quick installation and provided with leveling feet.
  - .4 The perforated inlet and outlet panels shall have 81% open area.
- .3 300 mm (12 in.) wide units
  - .1 Exterior panels shall be 20-gauge steel and powder-coated with charcoal color paint to protect against corrosion.
  - .2 Side panels shall be lined with half-inch closed-cell polymeric insulation and secured using quarterturn fasteners.
  - .3 The cabinet shall be mounted on casters for quick installation and provided with leveling feet.
  - .4 Both doors shall have a powder-coated sheet-metal frame with hexagonal perforations leaving 81% of the door open to air flow for efficient cooling.

- .5 The front and rear doors shall swing 170 degrees open, shall be removable, and shall feature a two-point latch.

## 2.3 VARIABLE SPEED FAN ASSEMBLY

- .1 600 mm (24 in.) wide units shall be equipped with two plug fans: direct-driven centrifugal fans with backward-curved blades and electronically-commutated DC motors; commonly referred to as EC plug fans.
- .2 300 mm (12 in.) wide units unit shall be equipped with six plug fans: direct-driven centrifugal fans with backward-curved blades and electronically commutated DC motors; commonly referred to as EC plug fans.
- .3 The fan speed shall be variable and automatically regulated by the CRAC unit controller through all modes of operation.
- .4 Each fan shall have a dedicated motor, fault monitoring circuitry and speed controller which provides a level of redundancy.
- .5 The impellers shall be heavy-duty steel with self-aligning, permanently sealed, pillow-block bearings with a minimum L3 life of 200,000 hours and balanced.
- .6 The EC plug fans shall be mounted to be easily accessible.
- .7 The fans shall be located to blow or draw air through the filters and tilted-slab cooling coil to ensure even air distribution and maximum coil performance.

## 2.4 BAFFLE SYSTEM

- .1 A field-adjustable, modular, supply-air baffle system shall be located in the discharge air stream on the front of the cabinet to direct air toward the equipment racks and balance air-flow requirements within the row.
- .2 The modular baffle segments shall be easily reconfigurable to redirect air flow as cooling requirements change. Controlling the air flow prevents hot spots and maintains high return-air temperatures by not blowing cold air over racks or out the ends of aisles. By focusing the cold air where it is needed and meeting the servers' requirements, the need for excessive air flow and energy consumption is eliminated.

### COOLING COIL

- .3 Cooling coil shall be constructed of 9.5-mm (3/8-in OD) copper tube coils and hydrophilic-coated aluminum fins.
- .4 The hydrophilic coating shall significantly improve the speed of condensate drainage from the fins and shall provide superior water carryover resistance.
- .5 The water circuit shall be threaded shut with a nitrogen holding charge. Field-relief of the Schrader valve shall indicate a leak-free system.
- .6 Coil end supports shall be a minimum 18 gauge galvanized steel.
- .7 Coil shall be rated for a maximum pressure of 2070 kPa (300 psig).
- .8 The coil shall be configured in a counterflow, tilted-slab, arrangement to enhance heat transfer efficiency.

## 2.5 CONDENSATE DRAIN PAN AND PUMP

- .1 600mm (24") wide units shall consist of two stainless-steel condensate drain pans, a primary drain pan and a secondary drain pan. The secondary drain pan shall be piped to the primary pan for removal of condensate.
- .2 600mm (24") wide units shall consist of a single stainless-steel condensate drain pans.
- .3 The primary drain pan shall include a dual-float condensate pump, sized by the supplier, with a flow (GPM/LPM) and head (ft/m) suitable to evacuate the condensate.

- .4 The pump shall be complete with integral primary and secondary float switches, pump, motor assembly and reservoir. The secondary float shall send a signal to the local alarm and shut down the unit upon high water condition

## 2.6 3-WAY MODULATING VALVE

- .1 A proportional valve shall be controlled (via the microprocessor) to automatically direct the proper amount of chilled water in the cooling coil to maintain desired conditions. A shut-off valve located in the bypass line may be manually adjusted for 2-way flow if so desired.
- .2 Three-way control valve shall be rated for 360 psig with a brass body and nickel/chromium-plated brass ball.
- .3 Valve Actuator: Actuator shall be a direct connection rotary proportional actuator with analog signal feedback and should be capable of being replaced without disconnecting piping from the valve. Ability for manual operation is also provided.

## 2.7 FILTERS

- .1 The filter channel shall be an integral part of the system, located within the cabinet and serviceable from the rear. The two filters shall be deep-pleated, 4 inches thick with an ASHRAE 52.2 MERV8 rating (30% ASHRAE 52.1).
- .2 A filter clog alarm shall be included. Mesh type, cleanable filters shall be unacceptable.
- .3 The filters shall be located within the cabinet and removed from the front of the cabinet .

## 2.8 ELECTRIC REHEAT

- .1 The low-watt density, 304/304, stainless-steel, finned-tubular electric reheat coils shall be capable of maintaining room dry bulb conditions when the system is calling for dehumidification.
- .2 The reheat section shall include UL/CSA recognized safety switches to protect the system from overheating.
- .3 The capacity of the reheat coils shall be controlled in one stage.
- .4 The reheat elements shall be accessible from the front of the cabinet.

## 2.9 STEAM GENERATING CANISTER HUMIDIFIER

- .1 A canister-type steam-generating humidifier shall be factory-installed in the cooling unit and operated by the CRAC unit controller.
- .2 It shall be complete with disposable cylinder, all supply and drain valves, steam distributor and electronic controls.
- .3 The humidifier shall be designed to operate with water conductivity from 330 to 670 (60 Hz) microS/cm. The system shall automatically fill and drain as well as maintain the required water level based on conductivity.
- .4 An air gap within the humidifier assembly shall prevent back-flow of the humidifier supply water.
- .5 The need to change the canister shall be indicated on the CRAC unit controller. The humidifier canister shall be removable from the front of the cabinet.

## 2.10 SELECTABLE TOP OR BOTTOM PIPING

- .1 If bottom piping connections are standard from factory, Unit shall be field modified for top piping. Unit connections shall be made internal to the unit.

## 2.11 FLOW METER

- .1 The flow meter shall be factory piped inside the unit and connected to microprocessor controls to provide water flow rate through the unit. The microprocessor controller shall also use this information to provide total unit capacity out of the unit while in operation.
- .2 The flow meter shall be a glass filled nylon construction vortex-sensing meter, compatible with glycol/water solutions up to 50% with accuracy of 2.5% FS @ 10–200 LPM (2.6–53 GPM).

#### 2.12 MAIN DISCONNECT SWITCH

- .1 Unit shall be provided with a fuse rated per UL 248-1/UL 248-14/CSA-C22.2 No. 248.1/CSA-C22.2 No. 248.14.
- .2 The manual disconnect switch shall be mounted in the high-voltage section of the electrical panel and be capable of disrupting the flow of power to the unit. The electric-panel compartment shall be accessible only with the switch in the Off position. It shall be located behind the door for quick access.

#### 2.13 SHORT-CIRCUIT CURRENT RATING

- .1 The electrical panel shall provide at least 65,000A SCCR (60hz).
- .2 Short-circuit current rating (SCCR) is the maximum short-circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.

#### 2.14 MICROPROCESSOR CONTROLLER

- .1 The Unit shall be factory-set to allow precise monitoring and control of the condition of the air entering and leaving the unit. This control shall include predictive methods to control air flow and cooling capacity based control sensors installed. Proportional and Tunable PID shall also be user-selectable options.
- .2 The unit shall be microprocessor-based with a 9" resistive, color-touchscreen display and shall be mounted in an ergonomic, aesthetically pleasing housing. The controls shall be menu driven. The system shall display user menus for active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in percentage of each function, date, and time), total run hours, various sensors, display setup, and service contacts. A password shall be required to make system changes. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards, and diagnostics/service mode.
- .3 Password Protection – The Unit shall contain two unique passwords to protect against unauthorized changes. An auto hide/show feature allows the user to see applicable information based on the login used.
- .4 Unit Backup and Restore – The user shall be able to create safe copies of important control parameters. The Unit shall have the capacity for the user to automatically backup unit configuration settings to internal memory or USB storage drive. Configuration settings may be transferred to another unit for a more streamlined unit startup.
- .5 Parameter Download – The Unit shall enable the user to download a report that lists parameter names, factory default settings and user-programmed settings in .csv format for remote reference.
- .6 Parameter Search – The Unit shall have search fields for efficient navigation and parameter lookup.
- .7 Parameter Directory – The Unit shall provide a directory that lists all parameters in the control. The list shall provide Line ID numbers, parameter labels, and current parameter values.



- .8 Context-Sensitive Help – The Unit shall have an on-board help database. The database shall provide context sensitive help to assist with setup and navigation of the menus.
- .9 Display Setup – The user shall have the ability to configure the Unit information based on the specific user's preference. Language, units of measure, screen contrast, home screen layout, back-light timer and the hide/show of certain readouts shall be configurable through the display.
- .10 Additional Readouts – The Unit shall permit the user to configure custom widgets on the main screen. Widget options shall include items such as fan speed, call for cooling, call for free-cooling, maintenance status, call for hot water reheat, call for electric reheat, call for dehumidification, call for humidification, airflow, static pressure, fluid flow rate and cooling capacity.
- .11 Status LEDs – The Unit shall provide the user with the unit's operating status using an integrated LED. The LED shall indicate if the unit has an active alarm; if the unit has an active alarm that has been acknowledged; or if the unit is On, Off or in standby status.
- .12 Event Log – The Unit shall automatically store the last 400 unit-only events (messages, warnings, and alarms).
- .13 Service Contact Information – The Unit shall have the ability to store the local service or sales contact information.
- .14 Upgradeable – Unit firmware upgrades shall be performed through a USB connection.
- .15 Timers/Sleep Mode – The menu shall allow various customer settings for turning the unit On or Off.
- .16 Menu Layout – The menus shall be divided into two main menus: User and Service. The User screen shall contain the menus to access parameters required for basic unit control and setup. The Service screen shall be designed for service personnel and shall provide access to advanced control setup features and diagnostic information.
- .17 Sensor Calibration – The menus shall allow unit sensors to be calibrated with external sensors.
- .18 Maintenance/Wellness Settings – The menus shall allow reporting of potential component problems before they occur.
- .19 Options Setup – The menus shall provide operation settings for the installed components.
- .20 Auxiliary Boards – The menus shall allow setup of optional expansion boards.
- .21 Various Sensors – The menus shall allow setup and display of optional custom sensors. The control shall include four customer-accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display. When configuring the analog inputs, the selectable items to choose shall include air pressure, fluid pressure, temperature, percentage, general amperage, condenser amps, compressor amps, reheat amps, humidifier amps, unit amps, fan amps factory standard, and not used.
- .22 Diagnostics/Service Mode – The Unit control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as On or Off at the front display. Control outputs shall be able to be turned On or Off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.
- .23 The reheat and humidifier lockout shall include the necessary relays to disable the reheat and humidifier from an external 24V signal while on emergency power.

2.15 **NETWORK SWITCH AND MANAGEMENT CARD**

- .1 Provide network switch as necessary to network multiple CRAC unit controllers together. Network switched to be housed inside a steel enclosure secured with a key lock and contain two network switches, providing a total of 14 Ethernet ports available for unit-to-unit networking. Hard wired, 16AWG, 100-240VAC universal (12V, 1.5A) single-phase input power supply for 120V or 230V operation with factory supplied power connector.
- .2 The unit controller shall provide one Ethernet Port and RS-485 Port dedicated for BMS Connectivity. Provides ground fault isolated RS-485 BACnet IP network connectivity to Building Management Systems for unit monitoring and management. Also, provides ground fault isolated 10/100 base Ethernet connectivity for unit monitoring and management. The supported management interfaces include: SNMP for Network Management Systems, HTTP for web page viewing, SMTP for email. The unit controller can support dual IP on a single network and one 485 protocol simultaneously.
- .3 Management through the network should include the ability to change set points as well as view and clear alarms.
- .4 BAS interface:
  - .1 Provide BAS interface and fire suppression interface. Refer to control drawings and sequence of operation depicted in 25 95 00 series for additional requirements.

## 2.16 ALARMS

- .1 All unit alarms shall be annunciated through both audio and visual cues, clearly displayed on the screen, automatically recorded in the event log and communicated to the customers Building Management System/Building Automation System. The Unit control shall activate an audible and visual alarm in event of any, but not limited, of the following conditions:
  - .1 High Temperature
  - .2 Low Temperature
  - .3 High Humidity
  - .4 Low Humidity
  - .5 EC Fan Fault
  - .6 Change Filters
  - .7 Loss of Air Flow
  - .8 Loss of Power
  - .9 Humidifier Problem
  - .10 Custom Alarms
- .2 Custom alarm inputs shall be provided to indicate facility-specific events. Custom alarms can be identified with programmable labels, to include:
  - .1 Leak Under Floor
  - .2 Smoke Detected
  - .3 Standby Unit On
- .3 Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm and programmed for a time delay of 0 to 255 seconds.

## 2.17 TEMPERATURE / HUMIDITY CONTROL AND SENSORS

- .1 Controls shall be flexible in the sense that it shall allow for controlling the capacity and fan from multiple different sensor selections The sensor selections shall be:
  - .1 Cooling Capacity (Supply, Remote, Return)

- .2 Fan Speed (Supply, Remote, Return, Manual (for diagnostic)
- .2 Temperature Compensation: CRAC unit controller shall be able to adjust the capacity output based on supply and return temperature conditions to meet SLA guidelines while operating to highest efficiency
- .3 Humidity Compensation: Dew point and relative humidity control methods shall be available (based on user preference) for humidity control within the conditioned space.
- .4 Internal Temperature Sensors: Thermister temperature sensors shall be mounted behind the front and rear doors to provide control inputs based on supply and return air temperature. Sensor accuracy shall be within  $\pm 2^{\circ}\text{F}$  ( $\pm 1^{\circ}\text{C}$ ) accuracy.
- .5 Water Temperature Sensors: Internal supply and return chilled water temperature sensors shall be installed into sealed wells. Wells are filled with thermal conducting heat transfer grease to provide accurate temperature sensors.

## 2.18 MULTI-UNIT COORDINATION

- .1 Unit shall save energy by preventing multiple units in an area from operating in opposing modes. The control shall optimize a group of connected cooling units. There shall be three modes operation:
  - .1 Mode 1 (Parallel): Is best in small rooms with balanced heat loads. The controlling temperature and humidity sensor readings of all units in operation (fan On) are collected to be used for an average or worst case sensor reading (user selectable). The master unit shall send the operating requirements to all operating units in the group. The control band (temperature, fan and humidity) is divided and shared among the units in the group. Each unit will receive instructions on how to operate from the Master unit based on how far the system deviates from the setpoints. Evaporator fans and cooling capacity are ramped in parallel.
  - .2 Mode 2 (Independent): Unit control shall calculate the worse-case demand for heating, cooling humidification and dehumidification. Based on the greatest demand within the group, each unit operates independently, meaning that the unit may respond to the thermal load and humidity conditions based on the unit's controlling sensors. All sensor readings are shared.
  - .3 Mode 3 (Optimized Aisle): May be employed in large and small rooms with varying heat loads. Optimized Aisle is the most efficient teamwork mode that allows the unit to match cooling capacity with heat load. In the Optimized Aisle mode, the fans operate in parallel. Fans can be controlled exclusively by remote temperature or using static pressure with a secondary remote temperature sensor(s) as an override to ensure that the inlet rack temperature is being met. Cooling (Compressors) is controlled through unit supply-air conditions. The controls calculates the average or worst-case sensor reading (user-selectable) for heating, cooling humidification, and dehumidification. Based on the demand within the group, units will be allowed to operate within that mode until room conditions are satisfied

## 2.19 STANDBY UNIT CASCADING

- .1 The Unit cascade option shall allow the units to turn On and Off based on heat load when utilizing Optimized Aisle, Mode 3 and remote temperature sensors.
- .2 Cascade mode dynamically coordinates the fan speed to save energy and to meet the cooling demands.
  - .1 For instance, with group of four units and only 40% of the heat load, the controls shall operate only two units at 80% fan speed and leave the other two units in standby.
  - .2 As the heat load increases, the controls shall automatically respond to the additional load and bring on another unit, increasing the units in operation to three.

- .3 As the heat load shifts up or down, the control shall meet the needs by cascading units On or putting them into standby.

## 2.20 REMOTE RACK TEMPERATURE SENSORS

- .1 Provide rack temperature sensors, each consisting of a vented case with two temperature probes.
- .2 The sensors shall provide real-time, direct feedback to the cooling unit to optimize the amount of cooling and airflow provided. The sensor data shall be available to remote BMS and monitoring systems.
- .3 The sensor network shall consist of one CAN wire leaving the cooling unit and connecting to a 2T sensor. Each remaining 2T sensor is connected to the previous sensor.

## 2.21 SYSTEM AUTO RESTART

- .1 The auto restart feature shall automatically restart the system after a power failure. Time delay shall be programmable. An optional capacitive buffer may be provided for continuous control operation through a power failure.

## 2.22 LEAK DETECTION MODULE WITH CABLE KIT FOR REMOTE MOUNTING

- .1 Provide one zone water sensor cable and leak detection module per CRAC.
- .2 Cable shall have no moving parts and hermetically sealed to keep out dust and dirt.
- .3 Leak detection module:
  - .1 Shall constantly monitor points for leaks, internal faults and power failures and warn of any abnormal conditions. LED's shall provide status indication and also ensure the cable is properly installed and operational under raised floors.
  - .2 Shall provide two independent outputs provide a signal to a local alarm panel, and remote building management system or external equipment.
  - .3 Shall consist of a metal enclosure with a hinged top door providing access to the internal circuit board for wiring termination and configuration of DIP switches.
  - .4 Shall monitor up to 100 feet (30m) of connected
- .4 Leak detection cable:
  - .1 Shall be rated for 24VAC, 50/60Hz and 0.12A. 2.
  - .2 The cable material and construction shall allow the cable to lie flat when used with hold-down clips.
  - .3 Shall be plenum-rated and UL-listed for safe operation.
  - .4 Cables shall be available in lengths of 20, 25, 30, 35 and 45 feet (6, 7.6, 9, 10.6 and 13.7m).

## 3 EXECUTION

### 3.1 INSTALLATION

- .1 Install as indicated, and to manufacturer's recommendations.
- .2 Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.
- .3 Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

- .4 Install and connect devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.
- .5 Connect water supply and drains to air-conditioning unit. Provide pitch and trap as manufacturer's instructions and local codes requirements. Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.
- .6 Start the system in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. These specifications describe requirements for a computer-room environmental-control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment.
- .7 Protect installed products and components from damage during construction.
- .8 Repair damage to adjacent materials caused by computer room air conditioning installation.
- .9 Engage manufacturer's field service technician to provide warranty start-up supervision and assist in programming of unit(s) controls and ancillary panels. Provide services of manufacturer's Professional Engineer to set and adjust equipment for operation as specified.

**END OF SECTION 23 81 73**

1 GENERAL

1.1 REFERENCE STANDARDS

- .1 Air-Conditioning, Heating, and Refrigeration Institute (AHRI)
  - .1 ANSI/AHRI 440, Performance Rating of Room Fan-Coils.
- .2 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .3 American Society of Testing and Materials (ASTM)
  - .1 ASTM B75/B75M, Standard Specification for Seamless Copper Tube.
- .4 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.2, No. 94-M, Special Purpose Enclosures.
  - .2 CAN/CSA C22.2, Canadian Electrical Code
- .5 National Building Code 2015 (NBC)
- .6 International Organization for Standardization (ISO)
  - .1 ISO 3744 Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane

1.2 SUBMITTALS

- .1 Product Data: Submit the Manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 – Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
  - .1 Provide fan performance data showing points of operation, entering air temperature, leaving air temperature, kW (bhp), static pressure, and efficiency.
  - .2 Provide hydronic performance data including entering water temperature, leaving water temperature, flow rate, and pressure drop.
  - .3 Submit drawings indicating overall dimensions as well as installation, operation, and service clearances. Indicate operating weights, construction materials, components and options.
  - .4 Submit data on electrical requirements and connection points including wiring diagram.
- .3 Closeout Submittals: Provide operation and maintenance data for incorporation into the O&M manual specified in Section 01 70 00 – Execution and Closeout Requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan (WMP).
- .4 Follow all written instructions and store at temperatures and conditions recommended by the Manufacturer.

1.4 **WARRANTY**

- .1 Provide parts warranty for two (2) years from shipment date.

2 **PRODUCTS**

2.1 **FAN COIL UNIT**

- .1 Furnish and install ducted 2-pipe and 4-pipe (single coil block) fan coil units where indicated or scheduled on the Drawings. Units shall be complete with water coil(s), fan(s), motor(s), drain pan, and all required wiring, piping, and special features. Cooling and heating capacities shall be based on AHRI Standard 440. Acoustic performance data shall be based on ISO 3744. The manufacturer must guarantee the following:
  - .1 FCU performance for flow, pressure, and acoustics at the perimeter boundary of the unit.
  - .2 Any corrective acoustical treatment increased electrical services (fan power), or coil modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the Owner.
- .2 Casing: Fan coil units shall consist of heavy gauge galvanized steel G90 casing. Casing shall be insulated with minimum 13mm (½ in.) thick fiberglass insulation. Units shall be low-profile.
- .3 Casing Finish: Painted finish shall be factory applied, consisting of a two-pass electrostatically applied baked power epoxy on cleaned and primed casing surfaces.
- .4 Fan & Motor: ECM fully modulating centrifugal forward curve fans with 0-10V control interface and unit mounted electrical disconnect. Provide continuous duty TEFC motor conforming to requirements specified in Section 20 05 00. Provide IP44 protection, Class F insulation, anti-vibration mounts on both sides, and maintenance-free ball bearings. The motor shall be direct connected to the fan. Fan shall be constructed of galvanized steel, with dual inlet with GreenTech technology, and shall be statically and dynamically balanced.
- .5 Coils: Coil elements and heaters shall be factory leak tested at 450 psig and designed for a working pressure of 150 psi. Coils shall be constructed of heavy wall drawn seamless copper tubing to ASTM B75. Element tubes shall be brazed into extruded heater junctions. Pipe connection saddles shall be bronze. Copper tubing shall be mechanically expanded into and permanently bonded to continuous plate type aluminum fins. Copper tubing shall be equipped with 1/2" or 3/4" NPT supply and return piping connections as well as manual air-vents on both supply and return piping. Provide a removable, reversible, cleanable double sloped drain pan for base of coil constructed of powder-coated galvanized steel with impermeable insulation with extension for valve section.
- .6 Filters: Provide return-air filters. Factory installed filters shall mount integral to the unit and shall be accessible for removal and inspection. Filters shall be MERV 8 rating in accordance with ASHRAE 52.2.
- .7 Controls: Refer to Section 25 00 00 for fan coil unit controls.
- .8 Sound: units shall be ultra-quiet and shall not exceed sound information listed in schedules
- .9 Regulatory Requirements
  - .1 All base or standard units shall conform to CSA C22.2 signifying the units are in compliance with Canadian applicable standards.
- .10 Acceptable manufacturers are:
  - .1 Kampmann
  - .2 Trane (Ingersoll Rand PLC.)
  - .3 Enviro-Tec (EFI)

- .4 Daikin (HTS)
- .5 York (Johnson Controls)
- .6 Engineered Air

### 3 EXECUTION

#### 3.1 INSTALLATION OF FAN COIL UNITS

- .1 Provide fan coil units where shown.
- .2 Secure fan coil units in place at the proper height by means of hanger rods attached to the structure. Ensure that fan coils are level and plumb. Refer to Section 20 05 48 for vibration isolation.
- .3 Connect with piping in accordance with the Drawings and detail. When lacking such information conform to manufacturer's installation instructions and piping detail.
- .4 Contractor to pipe coil condensate connection to nearest service sink, or floor drain. Where drainage to nearest service space cannot be achieved via gravity, a condensate pump shall be provided.

**END OF SECTION 23 82 19**



1 GENERAL

1.1 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA).
  - .1 CAN/CSA C22.2, No. 94-M, Special Purpose Enclosures.
  - .2 CAN/CSA C22.2, Canadian Electrical Code.
  - .3 CSA 2.34-2008 / ANSI Z83.20-2008, Gas-Fired Low-Intensity Infrared Heaters.
- .2 National Building Code 2015 (NBC).

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit the Manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 – Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Shop Drawings:
  - .1 Provide fan performance data showing points of operation, entering air temperature, leaving air temperature, kW (bhp), and efficiency.
  - .2 Provide hydronic performance data including entering water temperature, leaving water temperature, flow rate.
  - .3 Provide natural gas performance data including flue and combustion gas flow / flue requirements.
- .4 Closeout Submittals: Provide operation and maintenance data for incorporation into the O&M manual specified in Section 01 70 00 – Execution and Closeout Requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 60 00 – Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with the Manufacturer's name and address.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan (WMP).
- .4 Store at temperatures and conditions recommended by the Manufacturer.

2 PRODUCTS

2.1 UNIT HEATERS

- .1 Furnish and install hot water unit heaters where indicated or scheduled on the Drawings. All units shall be CSA certified and complete with.
- .2 Casing - Horizontal Unit: Shall be minimum 20 gauge die-formed steel, top and back halves. Both halves shall be joined on top and back with screws. Top casing shall be furnished with threaded hanger connections for suspension of unit. Fan venturi shall be die-formed on the back half.
- .3 Casing Finish: Painted finish shall be factory applied, consisting of a two-pass electrostatically applied baked power epoxy on cleaned and primed casing surfaces.
- .4 Heating Coil: Coil elements and heaters shall be factory leak tested and designed for a working pressure of 150 psi. Coils shall be constructed of heavy wall drawn seamless copper

tubing. Element tubes shall be brazed into extruded heater junctions. Pipe connection saddles shall be bronze. Copper tubing shall be mechanically expanded into and permanently bonded to continuous plate type aluminum fins and equipped with screwed steel supply and return piping connections and silver brazed tube joints.

- .5 Fan & Motor: Continuous duty TEFC motor with ball or sleeve bearings and conforming to requirements specified in Section 20 05 00. The motor shall be direct connected to a balanced hub type fan wheel with aluminum blades secured to a steel hub and finger proof fan guard meeting all CSA and OSHA requirements.
- .6 Controls - Thermostat & Motor Starter: By Mechanical/BAS contractor.
- .7 Acceptable manufacturers are:
  - .1 Trane (Ingersoll Rand PLC.)
  - .2 Sigma Corporation
  - .3 Rosemex Inc.
  - .4 Engineered-Air.

## 2.2 CABINET UNIT HEATERS

- .1 Furnish and install hot water cabinet heaters where indicated or scheduled on the Drawings. All units shall be CSA certified and complete with.
- .2 Cabinet: Shall be of welded fabrication, constructed from one-piece top and sides, and one-piece partition panels and backsheet, both die-formed from single sheets of minimum 16 gauge furniture grade steel and complete with minimum 825 mm (9") space at each end for piping and wiring, stamped grilles where required, and, for surface floor and wall mounted cabinets, key lock access doors for access to valves and speed controls
- .3 Front Panel: Minimum 16 gauge removable front panel with fasteners, stamped grille, and insulation applied to the inside face. The removable panel shall be hinged and provide uninhibited access to the motor, fans, controls and heating coils. Recessed unit shall be supplied with a recessing collar.
- .4 Cabinet Finish: For all exposed surfaces, a baked enamel prime coat finish applied to cleaned metal surfaces
- .5 Heating Coil: Coil elements and heaters shall be factory leak tested and designed for a working pressure of 150 psi. Coils shall be constructed of heavy wall drawn seamless copper tubing. Element tubes shall be brazed into extruded heater junctions. Pipe connection saddles shall be bronze. Copper tubing shall be mechanically expanded into and permanently bonded to continuous plate type aluminum fins and equipped with screwed steel supply and return piping connections and silver brazed tube joints.
- .6 Fan & Motor: A removable galvanized steel fan board with centrifugal, forward curved, formed aluminum fan wheel(s) with galvanized steel housings, direct connected to a continuous duty, three-speed permanent split capacitor motor conforming to requirements specified in Section 20 05 00.
- .7 Controls – Thermostat & Motor Starter: By Mechanical/BAS contractor.
- .8 Acceptable manufacturers are:
  - .1 Trane (Ingersoll Rand PLC.)
  - .2 Sigma Corporation.
  - .3 Rosemex Inc.
  - .4 Eng-Air.
  - .5 Zehnder-Rittling.

3 EXECUTION

3.1 INSTALLATION OF UNIT HEATERS

- .1 Provide motorized unit heaters where shown.
- .2 Secure unit heaters in place at the proper height by means of hanger rods attached to the structure. Ensure that the heaters are level and plumb.
- .3 Install self-actuating control valves with temperature controller inside heater enclosure with remote thermostat.
- .4 Unless otherwise indicated, mount room thermostats 1.5 m above the finished floor level. Confirm exact location of all thermostats prior to roughing-in.
- .5 Connect with piping in accordance with the Drawings and detail. When lacking such information conform to manufacturer's installation instructions and piping detail.

3.2 INSTALLATION OF CABINET HEATERS

- .1 Provide motorized cabinet unit heaters where shown.
- .2 Install recessed or semi-recessed wall mounted cabinet heaters in the wall openings provided. Ensure that each wall opening is deep enough to accommodate 25 mm (1") thick rigid board fiberglass insulation between the back of the heater and the wall. Provide such insulation.
- .3 Secure suspended ceiling mounted cabinet heaters in place by means of hanger rods, flush with the suspended ceiling. Install trim.
- .4 Connect with piping in accordance with the Drawings and detail. When lacking such information conform to manufacturer's installation instructions and piping detail.
- .5 Unless otherwise indicated, mount room thermostats 1.5 m above the finished floor level. Confirm exact location of all thermostats prior to roughing-in.

4 END OF SECTION 23 82 39

1 GENERAL

1.1 INTENT

- .1 Provide and install a new Building Management/ Automation System (BAS) incorporating it into the Owner's existing Niagara 4 Framework enterprise system to control, monitor and report on the operation of all equipment and devices as specified in the Contract Drawings and Specification including but not limited to:
  - .1 Panel mounted Human Machine Interface (HMI) to use as a secondary interface into the BAS c/w connectivity to each BAS control panel. Primary function of HMI is to provide local access to BAS when web browser access (via laptop, table, or smart phone) is unavailable.
  - .2 Where equipment is provided/ needed for redundancy, controllers are to maintain the level of redundancy of the equipment they serve. Controllers should be considered as a single point of failure, and one controller should not serve both the base, and redundant equipment.
  - .3 Building Automation Control systems to be provided with spare capacity to allow for future expansion. This includes main control points and boards, controllers, software, etc. both with respect to physical space allowances, and hardware allowances.
  - .4 Buildings automation system shall incorporate all points needed for building performance measurement and verification, metering and energy consumption.
  - .5 Custom built graphics for the project including an overview, floor plans, individual graphics for each system and summary graphics for system comfort and mechanical equipment operation.
  - .6 It is the intent of this Section that the Air Handling Unit supplier is provided with the specified control components required to be installed within or on the air handling units for installation by the AHU manufacturer at its factory. The AHU manufacturer is to install the specified control components on or within the unit, including conduit for all control wiring and copper tubing for all differential pressure devices such as flow transmitters so that penetrations of the unit will not be required after the unit arrives at the Site.
  - .7 The Contractor is to provide all required installation documents, instructions and supervision required at the AHU manufacturer's factory to ensure that control components, including wiring, are installed according to this Section's requirements.
  - .8 The Contractor is to verify correct installation and operation of the controls at the AHU manufacturer's factory in conjunction with the manufacturer.
  - .9 All control components not installed on custom AHUs shall be field-installed by the Contractor.
  - .10 The Contractor shall provide all VFD's, motor starters, and ALL control wiring and interfaces to ALL mechanical equipment and devices and to all other external systems interfaced with the BAS.
- .2 The control system shall consist of a high speed, peer to peer network of direct digital controllers (DDC), a control system, connection to the client's central BAS web server to archive data and store system database, and a web-based operator interface. The system shall utilize distributed control and not rely on any single controller.
- .3 The system software shall be designed around open standards. The control system server shall be accessed using a web browser over the control system network, the owner's LAN, and over the internet (WAN/VPN). Remote access, over the internet, shall require no special software other than a web browser shall be required to access system information.

- .4 The BAS shall use BACnet/IP for communication to the HMI, the web server and for communicating between controllers. The system shall be designed around the ANSI/ASHRAE BACnet Standard 135. No gateways shall be used for communication between controllers provided and installed by this Section. Gateways may be used to communicate to systems provided by others, by written permission only.
- .5 The system architecture shall be designed such that a single controller shall only control a single system. Failure of a single controller shall not result in a system wide failure. Minor systems such as exhaust fans and reheat coils shall be exempt from the single controller rule.
- .6 The open system architecture shall allow the system to integrate to multiple vendors. Vendors are responsible for converting their system to the BACnet standard for integration into the BAS. Provide integration, assistance, interface and programming for systems provided by other Divisions into the new HVAC control system.
- .7 The system shall be capable of future expansion through the addition of control devices, DDC controllers and/or operator devices. System shall have the capability of a 20% expansion on all tiers.
- .8 The BAS software to be installed on a central server and shall provide the following functions, as a minimum:
  - .1 Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
  - .2 Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any control unit in the network, local or remote.
  - .3 The server shall include a master clock service for its subsystems and provide time synchronization for all control units.
  - .4 The server shall provide scheduling for all control unit and their underlying field control devices.
  - .5 The server shall provide demand limiting that operates across all control unit.
  - .6 The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shedding lists for effective demand control.
  - .7 The server shall implement the BACnet Command Prioritization scheme for safe and effective contention resolution of all commands issued to control unit.
  - .8 Each control unit supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
  - .9 The server shall provide central alarm management for all control unit supported by the server.
  - .10 Routing of alarms to display, printer, email and pagers
  - .11 View and acknowledge alarms
  - .12 Query alarm logs based on user-defined parameters
  - .13 The server shall provide central management of log data for all control units supported by the server.
  - .14 Log data shall include process logs, runtime and event counter logs, audit logs and error logs.
  - .15 Viewing and printing log data

- .16 Exporting log data to other software applications
- .17 Query log data based on user-defined parameters
- .18 Maintain all trending data for minimum 36 months.

## 1.2 REFERENCES

- .1 American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 135, BACnet-A Data Communication Protocol for Building Automation and Control Networks.
- .2 International Society of Automation (ISA).
- .3 Canadian Standards Associated (CSA).
- .4 CSA C22.1 - Canadian Electrical Code.
- .5 Underwriters Laboratories (UL).
- .6 National Building Code (NBC).
- .7 American National Standards Institute (ANSI):
  - .1 INCITS 4: Information Systems - Coded Character Sets - 7 Bit American National Standard Code for Information Interchange (7 Bit ASCII).
- .8 American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
  - .1 Handbook Fundamentals.
  - .2 Guideline 3: Reducing Emission of Fully Halogenated Refrigerants in Refrigeration and Air Conditioning Equipment and Systems.
  - .3 135: A Data Communication Protocol for Building Automation and Control Networks.
- .9 American Water Works Association (AWWA):
  - .1 C704: Propeller-Type Meters for Waterworks Applications.
- .10 Electronic Industries Alliance (EIA):
  - .1 TIA 232 F: Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange.
  - .2 485: Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi point Systems.
- .11 Federal Communications Commission (FCC).
- .12 International Organization for Standardization (ISO):
  - .1 8802-3: Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks.
  - .2 9001:2015, Quality management systems – Requirements.
- .13 National Fire Protection Association (NFPA):
  - .1 90A: Standard for the Installation of Air Conditioning and Ventilating Systems.
- .14 Underwriters Laboratories, Inc. (UL):
  - .1 916: Standard for Safety Energy Management Equipment.

## 1.3 DEFINITIONS

- .1 The terms "HVAC Control System," "Automatic Temperature Control System," "Building Automation System," and "Energy Monitoring Control System" shall be considered equivalent and used interchangeably for the purposes of this Contract.

- .2 Algorithm: A software procedure for solving a recurrent mathematical or logical problem.
- .3 Analog: A continuously varying signal or value (temperature, current, velocity, etc.).
- .4 Binary: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level.
- .5 Control Wiring:
  - .1 Wiring, high or low voltage other than power wiring required for proper operation of mechanical systems.
  - .2 Includes conduit, wire and wiring devices to install a complete control system including motor control circuits, interlocks, thermostats, and like devices.
  - .3 Includes wiring from DDC panels to all sensors and points defined in the Drawings, Device and Control Wiring Lists in Division 26, or specified herein and required to execute the sequence of operation.
- .6 Power Wiring:
  - .1 Includes necessary power wiring (120V and/ or 24V inclusive of transformers) to HVAC control devices, and digital controllers including terminal units and actuators.
- .7 Control Process: Software required to complete control loop from input signal to interlock logic and process calculation to final output signal control.
- .8 Deadband: Temperature range over which no heating or cooling energy is supplied, such as 22 to 25 degrees C; as opposed to single point changeover or overlap, or a range from a set point over which no control action is taken.
- .9 Direct Digital Control (DDC): Consists of microprocessor-based controllers with control logic performed by software. Analog to digital (A/D) converters transform analog values into digital signals that microprocessors can use.
- .10 Power Wiring: Line voltage wiring to mechanical equipment. Line voltage wiring that also serves as control circuit, such as line voltage thermostat, or involves interlocking with damper shall be considered control wiring.
- .11 Abbreviations that may be used in this Section:
  - .1 AI: Analog Input.
  - .2 AC: Air Conditioning.
  - .3 ANSI: American National Standards Institute.
  - .4 AO: Analog Output.
  - .5 ASC: Application Specific Controller.
  - .6 ASCII: American Standard Code for Information Interchange.
  - .7 ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.
  - .8 ATC: Automatic Temperature Control.
  - .9 AWG: American Wire Gauge.
  - .10 AWS: Advanced Operator Workstation (BACnet Standard).
  - .11 BACnet: Building Automation Controls Network.
  - .12 BAS: Building Automation System.
  - .13 BIBB: BACnet Interoperability Building Block.
  - .14 BCC: Building Control Contractor.

- .15 BCM: Building Control Module.
- .16 CMOS: Complementary Metal Oxide Semiconductor.
- .17 CPU: Central Processing Unit.
- .18 DB: Dry Bulb (temperature).
- .19 DDC: Direct Digital Control.
- .20 DI: Digital Input.
- .21 DO: Digital Output.
- .22 DX: Direct Expansion.
- .23 EP: Electro-Pneumatic.
- .24 EEPROM: Electronic Erasable Programmable Read Only Memory.
- .25 EIA: Electronic Industries Alliance.
- .26 EMCS: Environmental Management and Control System.
- .27 EEPROM: Electronically Erasable Programmable Read Only Memory.
- .28 EMI: Electromagnetic Interference.
- .29 EMT: Electrical Metallic Tubing.
- .30 GUI: Graphical User Interface.
- .31 IEEE: Institute of Electrical and Electronics Engineers.
- .32 HCP: HVAC Control Panel.
- .33 GLS/R: Hot Glycol Supply/Return.
- .34 HMI: Human-Machine Interface.
- .35 HOA: Hand-Off-Auto (Switch).
- .36 HVAC: Heating, Ventilation, and Air Conditioning.
- .37 I/O: Input/Output.
- .38 ISP: Internet Service Provider.
- .39 IP: Current (I) - Pressure (P), as in IP transducer.
- .40 LAN: Local Area Network.
- .41 LCD: Liquid Crystal Display.
- .42 LED: Light Emitting Diode.
- .43 MSCR: Manual Speed Control Regulators.
- .44 MCC: Motor Control Center.
- .45 NP: Non-potable Water.
- .46 OWS: Operator Workstation.
- .47 PC: Personal Computer.
- .48 PIC: Protocol Implementation Conformance Statement.
- .49 PLC: Programmable Logic Controller.
- .50 POI: Portable Operator's Interface.
- .51 POT: Portable Operator's Terminal.



- .52 PICS: Protocol Implementation Conformance Statement.
- .53 PICV: Pressure Independent Control Valve.
- .54 RAM: Random Access Memory.
- .55 RF: Radio Frequency.
- .56 RFI: Radio Frequency Interference.
- .57 RH: Relative Humidity.
- .58 RTD: Resistance Temperature Detectors.
- .59 TCP/IP: Transmission Control Protocol/Internet.
- .60 TRGSC: Threaded Rigid Galvanized Steel Conduit.
- .61 VLC: Visual Logic Field Controller.
- .62 WB: Wet Bulb (Temperature).
- .63 UPS: Uninterruptible Power Supply.
- .64 VLAN: Virtual Local Area Network.
- .65 VFD: Variable Frequency Drive.
- .66 WAN Wide Area Network.

#### 1.4 SUBMITTALS

- .1 Submit shop drawings in accordance with the requirements of Section 01 33 00 – Submittal Procedures.
- .2 Shop drawings shall be submitted electronically and/or hard copies, as per Contract agreement, on 11 x 17 paper.
- .3 Quantity of items submitted shall be reviewed but are the responsibility of the Controls Contractor.
- .4 Shop drawings to include:
  - .1 Title Page + Table of Contents
  - .2 Network Architecture:
    - .1 Network layout showing all networks associated with the Project.
    - .2 HVAC Control Systems network architecture drawings including all nodes, interconnections, and controller locations/identifiers.
    - .3 Connection to owner's LAN and/or internet.
    - .4 Details of all panels, controllers and routers provided for the Project including their location, type and power feed. DDC controller panel layout diagrams showing all components contained within and/or on panels.
    - .5 PIC/BIBB statement clarifying which BACnet objects and services are supported by each applicable controller.
    - .6 Operator interface devices (workstations, laptops etc.).
  - .3 Schematic Drawings:
    - .1 Provide detailed drawings showing equipment or system layout and complete points list.

- .2 Show location control devices on floor plans (panels, space sensors, pipe sensors, duct sensor, etc.). Coordinate locations of sensors with all other trades, regardless of whether they are shown on the Contract drawings.
- .3 Show "zone groups" on layout. Coordinate with client and consultant as necessary.
- .4 Provide bill of material for all devices.
- .5 Show controller point names and address for all devices.
- .4 Sequence of Operation:
  - .1 Use exact wording indicated on design drawings for sequences of operation. Changes to design sequences shall not be made without first discussing and getting approval from the Engineer.
  - .2 Provide detail description for the operation of each system.
  - .3 Indicate all modes of operation, safety interlocks, control strategies, alarms and operating procedures.
- .5 Schedules:
  - .1 Provide for all systems, control valves, control damper actuators, airflow stations, meters, terminal units and equipment as required.
  - .2 Control Damper Schedule including a separate line for each damper provided under this Section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting installation details and structural reinforcement and/or supports to meet system operational pressures and air flow velocities and /or wind loads for all building envelope installed dampers, and Actuator Type. Include damper actuator sizing calculations, in schedule form
  - .3 Control Valve Schedules including a separate line for each valve provided under this Section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body, Configuration, Close-off Pressure, Capacity, Valve pressure drop, Design Pressure, and Actuator Type. Include control valve sizing calculations, in schedule form.
- .6 Wiring Diagrams:
  - .1 Diagrams to show exact termination details for controllers and control devices.
  - .2 Control and power wiring diagrams for all connected systems, devices, indicating, equipment/ system interlocks, DDC control/monitoring points, control wiring interconnections to VFDs, equipment and devices, voltage requirements and all other network communication and other connections. In addition to any point/device nomenclature used by this Section indicate the Owner's required nomenclature as indicated on the Contract Drawings.
- .7 Data Sheets.
  - .1 Technical specification data sheets for each and every system component and software module. Clearly indicate the specific device part number/code being used where multiple selections and/or options are indicated. Include photo and description for all Products. For hardware devices include make, model, dimensions, weight of equipment, and electrical schematics, for all control system components.

- .8 List/ trends.
  - .1 Detailed lists of all trending (all control points shall be trended), alarms, alarm priority, setpoints and scheduling.
- .5 Operation and Maintenance Manuals
  - .1 An Operation and Maintenance manual shall be provided in both hard copy and compact disc media and shall include:
    - .1 Table of Contents
    - .2 The manufacturer's technical literature/specification for every system and component comprising the HVAC Control Systems.
    - .3 Calibration and maintenance instructions for all equipment.
    - .4 As-built (record) versions of shop drawings for all controlled systems. Revised shop drawings to reflect required changes discussed and agreed upon during the commissioning process.
    - .5 Layout drawings showing the installed location of all hardware devices.
    - .6 Interfaces to all third-party Products and work by Other Contractors.
    - .7 Descriptions and instructions on the use of all installed hardware, software (including the Graphical User Interface) and firmware. The level of detail shall be enough to permit the Owner to create their own colour graphics, including set-up of real time points, from scratch.
    - .8 Archive copy of all Site-specific databases, control programs (sequences) and setpoints.
    - .9 Licenses guarantee and warranty documents for all equipment and systems.
    - .10 As-built diagrams of all control panels, VFD external control interfaces and starter controls including hardware layouts and wiring diagrams, where applicable.
  - .2 The Operation and Maintenance Manual CD/DVD shall be self-contained, and include all necessary software required to access the Product data sheets. A logically organized table of contents shall provide dynamic links to view and print all Product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
  - .3 Maintenance manuals shall include instructions covering the operation, maintenance and troubleshooting of all controlled systems.
  - .4 Supply three (3) copies of HVAC Control Systems Manuals for the project.
  - .5 All manuals shall be finalized and available at the Site for use during operation and maintenance training.
  - .6 Provide copies of final installed software programs on CD/DVD ROM.
- .6 Information Submittals:
  - .1 Start-Up & Commissioning Data.
  - .2 A draft maintenance agreement.
  - .3 Confirmation that the control system supplier has received and coordinated with all approved HVAC equipment submittals.
  - .4 Experience and qualifications of the control system supplier's proposed representative who will supervise installation, adjustment, and calibration of control systems.

- .5 Performance test plan and schedule.
- .6 Test Results:
  - .1 Functional and performance test documentation.
  - .2 Component calibration sheets for each instrument and panel component.
- .7 Operation and maintenance data, including but not limited to the following detailed information:
  - .1 Operation and maintenance instructions for control system as furnished and installed, including control of associated mechanical and electrical equipment.
  - .2 Record of system adjustments and calibration methods.
  - .3 Performance test results.
- .8 Start-Up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements specified in other Contract sections.
- .9 Control Work Certification: When control work has been completed and has been tested and adjusted at the site, certify in writing that the controls are complete, operational, and ready for acceptance.

#### 1.5 GENERAL SYSTEM REQUIREMENTS

- .1 Provide a Niagara Frameworks 4 HVAC Control System consisting of a networked, fully distributed processing, on-line, real-time, direct digital control system consisting of microprocessor-based, direct digital controllers for control and monitoring of air handling, heating and ventilation, cooling and other specified systems. The HVAC Control System is to consist of the following:
  - .1 Human-Machine Interfaces (HMI) at BAS Panels.
  - .2 Web-based (ie. HTML 5) portal for access by portable devices (laptops, tablets, smartphones). Windows, iOS, and Android.
  - .3 Wired control devices and sensors. Written permission is required for wireless (Bluetooth, Wi-Fi) devices.
  - .4 Operating, application and system specific software.
- .2 The HVAC Control System network is to utilize an open architecture capable of each and all the following:
  - .1 Communication at the BCM level (Tier 1) via a high-speed Ethernet TCP/IP network configuration operating at a speed of 100 Mb/sec according to ANSI / ASHRAE™ Standard 135.
  - .2 Provide Modbus/TCP communication gateways at each piece of equipment (if necessary) to enable BACnet system to read HVAC control points. Equipment shall be native BACnet wherever possible.
- .3 The controls systems are to include the necessary hardware, equipment and software to allow all controls systems application facilities and features to be accessible via the Owner's WAN and an Internet Browser.
- .4 The software tools required to network manage the ANSI / ASHRAE™ Standard 135 BACnet protocol must be provided with the system.
- .5 All applicable devices shall have a Protocol Implementation Conformance Statement (PICS) that identifies all the portions of BACnet that are implemented.

- .6 The controls systems application software tool provided for the generation of custom and database definitions are to be resident in the BACnet Advanced Operator Workstation (AWS).
- .7 The system is to be modular in nature and is to permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices.
- .8 Each DDC Controller is to operate independently by performing its own specified control, alarm management, operator I/O and data collection.
- .9 All DDC Controllers are to be complete with all required hardware and software to permit connection together to form a network. This means that DDC controllers are to be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central processing device. DDC Controllers are to also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
- .10 VLCs are to have the capability to interface directly with a graphic display interface without the need for additional communication cards and software.
- .11 Major control components, material and equipment are to be the catalogue products of a single manufacturer regularly engaged in production and installation of automatic temperature control systems and accessories. All Products are to be manufacturer's latest standard design that complies with the specification requirements.
- .12 Install system using competent workmen who are fully trained in the installation of automatic HVAC Control Systems. Single source responsibility of the Contractor's supplier is to be for the complete installation and proper operation of the DDC control system and is to include debugging and proper calibration of each component in the entire system.
- .13 The OWS Graphical User Interfaces shall provide PC-based, user-friendly interfaces that afford an Operator the means to access and display information about any of the systems controlled and monitored by the HVAC Control Systems. Provide English language operator interfaces using readily understood abbreviations and descriptors to provide a convenient means by which an Operator can access information and modify setpoints, schedules and control points comprising the HVAC Control Systems.
- .14 The Contractor shall provide full technical assistance during testing, start-up, and commissioning of the overall system.
- .15 Provide and install a software on web-based server.

#### 1.6 CLIENT SPECIFIC REQUIREMENTS

1. Contractor must also review and adhere to all requirements in the Niagara Region Design Standard For Building Automation Systems (NRDS for BAS). If any discrepancy exists between the Division 25 specs and the Niagara Region Design Standard the contractor shall price for the more expensive option or ask for a clarification in writing during the tender period.
2. The equipment provided by the controls contractor must interface with the Region BAS network under BACnet/ IP (ASHRAE 135-2010) or Niagara Network protocols.
3. The BAS shall be on a separate local network with a single connection point to the Region's network. Niagara Region will be responsible for providing any data "drops" (if required). Contractor to submit request to Region Project Manager for approval.
4. The BAS network (riser) diagrams and point list must be approved by Region staff prior to ordering any BAS hardware. See NRDS for BAS for an example. Riser diagrams (based on communication protocol) must include Device ID, MAC addresses, Baud rates, as well as port and network numbers.

5. Prior to commencing programming, the selected controls contractor shall request from the Region Project Manager the Building number to be part of the supervisor point naming convention (refer to NRDS for BAS).
6. Region CE&FM and IT staff shall verify the network riser configuration prior to release of all holdbacks.
7. Vendor to supply all programming tools for field controller level programming to Niagara Region at commissioning stage. After commissioning, the new controls must be accessible by Region staff at all times for review and/or modification without special requirements other than a supervisory password. User access to the BAS to be coordinated with the Region.
8. All UI colour schemes, graphics, and equipment labelling shall be consistent with Niagara Region Standards and shall be submitted accordingly in the shop drawing submission (refer to NRDS for BAS)
9. The BAS platform shall be compatible with Single Sign On via Active Directory.
10. The BAS platform shall allow for multiple user access levels. They shall be as follows:
  1. Viewer Role:
    1. Viewer can view system operations, current equipment status, set-points, temperatures, readings and alarms
    2. Viewer cannot adjust schedule, settings, set points or point overrides.
  2. Operator Role
    1. Operators can view system operations, current equipment status, set points, temperatures, readings and alarms.
    2. Operators can make temporary adjustments to set points, schedules and temporary point overrides.
  3. Administrator Role
    1. Administrators can view system operations, current equipment status, set points, temperatures readings and alarms.
    2. Administrators can make temporary adjustments to set points, schedules and temporary point overrides.
    3. Temporary adjustments shall only last until the next schedule.
    4. Administrators can make permanent adjustments to set points, schedules and overrides.
    5. Administrators can adjust schedules to equipment.
    6. Administrators can create reports, add/remove users and adjust permission levels of all other roles (Viewer & Operator)
    7. The administrator role shall receive an alarm if a point has been overridden more than twice. This action requires acknowledgement or corrective action.

#### 1.7 WORK INCLUDED

- .1 Provide all labour, material, tool, equipment and services, testing, commissioning, training sessions required to deliver a complete and functional BAS as shown on the Contract Drawings and described in this Section and Section 25 95 00 – Sequence of Operations.
- .2 Supply, mounting as required, and connection of all required piping, duct and equipment/ room mounted control components.
- .3 Provision of all computer hardware and software, operator interface devices, the local area network (LAN), fiber optic network, field sensors, transmitters and other control components required to meet the specified performance criteria.
- .4 All required calibration, testing, commissioning, software programming and data base generation.

- .5 Provision of all instruments, panels, push buttons, accessories, communication protocol gateways and other system interfaces.
- .6 Coordination with Subcontractors and Other Contractors performing Work associated with the DDC controls, and coordination and cooperation with personnel performing mechanical, electrical, and other control system commissioning.
- .7 Provision of 120 V power wiring between electrical panel circuits, junction boxes, or other connection points provided under Division 26 and the controls equipment (eg. field-mounted DDC panels and other control components) requiring 120 V power. All required 120v/24v transformers. Power to AHU-mounted controls shall be through a 120 V power source termination provided at the unit by the AHU supplier.
- .8 Control sequences and functions including trending, scheduling, alarms, monitoring and resetting functions, shall not be limited to point schedules and sequences of operation.
- .9 Provide sequences and functions as required to deliver a fully functioning HVAC system.
- .10 Provide an intuitive graphical user interface that allows the operators to easily monitor and control all systems. Provide floor plans, navigational graphics and graphics for all systems under control.
- .11 Provide all DDC controllers, control devices, sensors, wiring, programming and commissioning for a fully operational system as described in this Section and Section 25 95 00 – Sequence of Operations.
- .12 Installation and Design:
  - .1 All aspects of the project shall be performed under the direct supervision of the Controls Contractor.
  - .2 The Control Contractor shall be responsible for the final design of the controls system based on the supplier/vendor of their choice. This includes design, wiring design, panel selection, field wiring, programming, testing commissioning and verification.
  - .3 Provide coordination services with other subcontractors as required.
- .13 Controllers and Software:
  - .1 Provide a BACnet based DDC control and monitoring system that utilizes distributed control for the system as shown on the Contract Drawings and described in this Section.
  - .2 System shall be web based and built around the ANSI/ASHRAE Standard 135 (BACnet).
  - .3 Provide all programming to deliver the system and sequences as described in this Section.
  - .4 Niagara 4 Framework shall be used as the software platform.
  - .5 All graphics and programs for the project shall be the property of the Owner. Provide backup copies of all programs and graphics.
  - .6 Provide all required Building Controllers.
  - .7 Provide all required Field Controllers.
- .14 Control Devices:
  - .1 Provide all control dampers and actuators for all control dampers as shown on the Contract Drawings and/or as described in Section 25 95 00 – Sequence of Operations.
  - .2 Provide all control valves and actuators as shown on the Contract Drawings and/or as described in Section 25 95 00 – Sequence of Operations.

- .3 Provide all control devices as shown on the Contract Drawings and/or described in Section 25 95 00 – Sequence of Operations.
- .15 Wiring:
  - .1 Supply and install all electrical 120v and 24v wiring for components. All wiring shall be in accordance with the governing electrical authority. This includes network wiring, wiring between control components and wiring from such components to electrical circuits of fans, pumps and any other piece of equipment.
  - .2 Electrical interlock wiring of field devices (i.e., flow switches, thermostats) associated with equipment specified under other sections of this Division is the responsibility of the contractor installing that equipment, unless indicated otherwise in this Section.
  - .3 Power at 120V/60Hz/1Ph shall be provided under Division 26 in each mechanical room, other rooms /ceiling for air terminals and each HVAC control panel and/or terminal units or package equipment and area as required by the control systems. This includes wiring and conduit up to control panels and electrical power from power panels to BAS panels. Controls Contractor to coordinate exact requirements and locations with Division 26.
- .16 Hardware and Software Verification:
  - .1 Provide all work and documentation to confirm that all devices are installed, wired, programmed and operating as intended.
  - .2 Provide all work and documentation to confirm that all systems are operating as described in the sequence of operation on the Contract Documents.
- .17 Operator Interface Devices:
  - .1 Provide operator workstations and laptop, as described in the Part 2 – Products of this Section.
  - .2 The operator workstations shall be located as per contract documents. Controls contractor shall confirm final location with the Owner.
  - .3 Include all hardware and software required.
- .18 Documentation:
  - .1 Provide shop drawings and all documents necessary to supply and install the BAS.
  - .2 Provide all verification reports as necessary to confirm the installed BAS is fully functional and meets the Contract requirements.
  - .3 Provide all as built shop drawings, training manuals and operating manuals as required for the operator to manage and operate the facility.
- .19 Commissioning and Training:
  - .1 Provide assistance as detailed in Part 3, “Testing and Balancing” of this Section and as required by the TAB Contractor and Commissioning Contractor to perform all aspects related to testing, adjusting, balancing and commissioning as detailed in Section 01 91 15 – Commissioning – Mechanical and Electrical and Section 20 05 93 – Testing, Adjusting, and Balancing (TAB).
  - .2 Provide training as detailed in Part 3, “Training” – Execution of this Section.
- 1.8 **RELATED WORK**
  - .1 Products furnished but not installed by this Section:
    - .1 Control valves;
    - .2 Immersion wells;



- .3 Air flow stations;
- .4 Liquid and Gas flow meters (for HVAC and plumbing flow control and energy monitoring).
- .2 Products installed but not furnished by this Section:
  - .1 None.
- .3 Products or services not furnished or installed by this Section:
  - .1 Electrical meters
  - .2 Access doors;
  - .3 Power wiring to control panels;
  - .4 Circuit breakers or power sources for controls; and,
  - .5 Internet connection.
- .4 BACnet devices provided by others for integration into the BAS:
  - .1 Chillers.
  - .2 Boilers.
  - .3 Packaged equipment.
  - .4 Computer room air conditioning units.
  - .5 Lighting.
- .5 Misc. devices provided by others for integration into the BAS:
  - .1 Electrical meters.
  - .2 Revenue Natural gas meters.
  - .3 Revenue Domestic water meters.
  - .4 Generators.
  - .5 Cogeneration units.
  - .6 Domestic water heaters.
  - .7 Fuel oil system.

#### 1.9 QUALITY ASSURANCE

- .1 Comply with the quality requirements of Section 01 40 00 – Quality Requirements.
- .2 All persons involved with the design, installation, programming and verification of the BAS shall be authorized and trained in Niagara 4 Framework.
- .3 All materials and devices used on this project shall be new, regularly manufactured and shall be of the latest design standard.
- .4 The installer shall have an established working relationship with the controls Supplier.
- .5 The Controls Contractor shall provide an experienced project manager to oversee all aspects of the project including design, installation and start-up.
- .6 Systems shall be the product of one manufacturer.
- .7 Systems shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

- .8 Materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards of Underwriters Laboratories, Inc. (UL), Underwriters Laboratories of Canada (ULC) and Canadian Standards Association (CSA).
- .9 Codes and Standards: Meet the requirements of the applicable standards and codes listed below, except when more detailed or stringent requirements are indicated by the Contract Documents, including the requirements of this Section.
  - .1 Underwriters Laboratories: Products shall be UL 916 PAZX listed or equivalent ULC and CSA listed.
  - .2 National Electrical Code NFPA 70.
  - .3 Federal Communications Commission Part J.
  - .4 Applicable portions of networked DDC Control Systems shall comply with latest version of ASHRAE 135 (BACnet).
- .10 Qualifications of HVAC Controls System Supplier:
  - .1 Minimum of 15 years' experience in design, installation, and maintenance of fully electronic building automation systems.
  - .2 Minimum of 10 years' experience in design, installation, and maintenance of computer based, direct digital control, facility automation systems.
  - .3 Capable of furnishing factory trained technicians, competent to provide instruction, routine maintenance, and emergency service on Site within 4 hours after receipt of request.
  - .4 Factory trained certified engineering and commissioning staff, and complete off Site training facilities.
  - .5 Necessary facilities to provide the Owner with complete maintenance, periodic inspection, and service contract. Refer to Maintenance subsection.
  - .6 FCC Regulation: Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- .11 Compatibility:
  - .1 System shall have documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years.
  - .2 Compatibility shall be defined as:
    - .1 Ability to upgrade existing field panels to current level of technology and extend new field panels on previously installed network.
    - .1 Ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers, or protocol converters.
- .12 Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
  - .1 Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
  - .2 Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:
    - .1 15 person-days.

- .3 Functional Completion Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.
  - .1 30 person-days.
- .4 Field Performance Testing: Field performance test equipment specified.
  - .1 30 person-days.
- .5 Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
  - .1 10 person-days.
- .6 Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
- .7 Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- 1.13 Manufacturer of systems shall have a minimum of five (5) operating installations with systems of the size specified and in the same service as specified operating for not less than five (5) years.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 40 00 – Quality Requirements, and Section 01 61 00 – Common Product Requirements.
- .2 Corrosion Protection:
  - .1 Control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through use of corrosion inhibiting vapor capsules.
  - .2 Prior to shipment, capsules shall be provided within shipping containers and equipment as recommended by the capsule manufacturer.
  - .3 During construction period, capsules shall be replaced in accordance with the capsule manufacturer's recommendations.
  - .4 All control panels shall be sufficiently protected by packaging prior to installation in order to prevent abrasion and denting of panels.

#### 1.11 MAINTENANCE

- .1 Maintenance Service Agreement.
- .2 Furnish a draft maintenance and service agreement, prepared and signed by the Controls supplier, to provide the necessary preventive maintenance to keep the various control systems in proper working condition.
- .3 Fully describe the maintenance Work to be performed and estimate the cost of the maintenance during the 24 month warranty period after Substantial Performance of the Work and the subsequent year.
- .4 This service contract shall include 24 hour emergency service, 7 Days per week.

#### 1.12 SYSTEM PERFORMANCE

- .1 The installed system shall conform to the minimum performance standards as described on the Contract Documents.
- .2 A graphic with 20 dynamic points shall display current data within 10 seconds.

- .3 A graphic with 20 dynamic points shall refresh every 15 seconds.
- .4 Screens for tuning shall refresh every 6 seconds.
- .5 Commands from operator interface to device shall take no longer than 5 seconds.
- .6 Alarms shall be annunciated at the workstation within 45 seconds.
- .7 Field level controllers shall execute PID loops at a response time suitable for the application with the capability of executing once per second.
- .8 Loop stability, but not limited to, and in accordance with the system control intent and operating range:
  - .1 Space temperature shall be maintained within +/- 1 Deg C of set-point.
  - .2 Return air humidity shall be maintained within +/- 5 %RH of set-point.
  - .3 Duct pressure shall be maintained within +/- 50 Pa of set-point.
  - .4 Fluid differential pressure shall be maintained within +/- 250 Pa of set-point.
  - .5 Air volume to be maintained within +/- 10% of set-point.

#### 1.13 FINAL DOCUMENTATION

- .1 Final documents shall be submitted within 4 weeks of acceptance.
- .2 Provide electronic copy of all documentation on CD. All electronic documents shall be in PDF format. Refer to Commissioning Plan and O&M manuals for delivery and quantity of copy format to required stakeholders.
- .3 Documentation to include:
  - .1 Revised as built shop drawings indicating exact installation details;
  - .2 Verification documents;
  - .3 O&M manuals;
  - .4 Copies of all programs, graphics and database;
  - .5 Copies of software specific to the Project and all licenses;
  - .6 List of recommended spare parts; and,
  - .7 Recommended preventative maintenance and operating procedures.

#### 1.14 OWNERSHIP OF PROPRIETARY MATERIAL

- .1 All project specific software and documentation shall become the Owner's property. This includes but is not limited to:
  - .1 Record drawings;
  - .2 Graphics;
  - .3 Programs;
  - .4 Licensed software and,
  - .5 Database.

#### 1.15 WARRANTY

- .1 Warranty shall cover all costs for parts, labour, associated travel and expenses for a period of two (2) years following substantial completion of the Project.
- .2 Control system failures during the warranty period shall be adjusted, replaced or repaired at no additional cost to the Owner.

- .3 Controls vendor shall respond to failures within 24 hours of a call for service during normal business hours.

#### 1.16 ACCEPTABLE MANUFACTURERS

- .1 The following Building Automation Systems, based on Niagara 4 Framework and controllers capable of being programed and edited via Niagara AX, are approved installation:
  - .1 Honeywell
  - .2 Alerton
  - .3 Siemens (TALON)
  - .4 Johnson Controls (Facility Explorer)
  - .5 Trane (Lynxspring)
  - .6 Distech

### 2 PRODUCTS

#### 2.1 MATERIAL

- .1 Use new products the manufacturer is currently manufacturing and selling for use in new installations.
- .2 Do not use this installation as a product test site unless explicitly approved in writing by the Engineer in writing.
- .3 Spare parts shall be available for at least five years after completion of this contract.
- .4 Control Components:
  - .1 Control the range to obtain the specified capacities.
  - .2 Sensitivity to maintain control points close enough to set point for acceptable offset, without cycling equipment more frequently than recommended by the manufacturer.
  - .3 Field or computer adjustable to actual set point ranges. Adjustable to other settings that will provide proper operation of entire control system.
- .5 Controls Interfacing:
  - .1 Interface controls properly with factory supplied components of mechanical systems. Coordinate special control interfacing requirements.
  - .2 For equipment that requires special interfacing with control system, provide equipment with integral controls or provide accessory devices required for operation of total mechanical system.
  - .3 Coordinate interfaces with electrical Work as necessary.
  - .4 Provide electric, electronic, and mechanical devices as required to properly interface with prewired control panels furnished with HVAC equipment and with other mechanical and electrical components.

#### 2.2 LABELING

- .1 All Products, namely electrical materials, devices, appliances, and equipment used, shall be indicated as acceptable by established standards of Underwriters Laboratories, Inc. (UL), Underwriters Laboratories of Canada (ULC), Factory Mutual (FM) and Canadian Standards Association (CSA).
- .2 A valid label affixed to an item shall provide indication of Product acceptance by the required agencies.

- .3 HVAC control panels and control components that consist of multiple components shall bear UL, ULC and CSA listing mark on unit.

## 2.3 SERVICE CONDITIONS

- .1 Refer to Division 26, and the Electrical Drawings for classification of areas as hazardous, corrosive, wet, indoor dry, and dust tight.
- .2 Use materials and methods and enclose devices in NEMA enclosure types suitable for the classification indicated, and as required by NFPA 70.
- .3 Exhaust ductwork shall be considered the same classification as the area served.
- .4 Instruments within 900 mm of ducts conveying air from spaces classified as Class I, Division 1 or 2 (in accordance with NFPA 70) shall be suitable for the same area classification as the space exhausted.

## 2.4 ELECTRICAL COMPONENTS AND ACCESSORIES

- .1 Electrical components shall be provided by Division 25 – Controls in accordance with the requirements of Division 26 - Electrical.
- .2 Wiring:
  - .1 In accordance with Division 26, NFPA 70 and Electrical Code
  - .2 Insulation shall be rated 600 volts, minimum.
  - .3 Electrical Raceways: In accordance with Division 26 and NFPA 70 and Electrical Code
  - .4 Starters: In accordance with Division 26 and NFPA 70 and Electrical Code

## 2.5 ACCESSORIES

- .1 Corrosion inhibiting vapor capsules as manufactured by:
  - .1 Northern Technologies International Corporation; Model Zerust VC.
  - .2 Hoffman Enclosures Inc.; Model A HCI
  - .3 Or approved equivalent
- .2 Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 45 kg.
- .3 Equipment Identification Plates:
  - .1 Provide a 16 gauge type stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. The plate shall bear 6 mm high engraved block type black enamel filled equipment identification number tags indicated on the Drawings. Provide Identification list for Owner approval prior to purchase or fabrication.
  - .2 Provide on or adjacent to all control devices, and for equipment whose function is not readily apparent, including:
    - .1 Manual Speed Control Regulators
    - .2 Fan Control Stations
    - .3 Special purpose devices.
    - .4 HVAC control panels.

## 2.6 EQUIPMENT FINISH

- .1 Provide materials and equipment with the manufacturer's standard finish system. Provide manufacturer's standard finish colour, except where a specific colour is indicated in the Contract Documents.
- .2 If manufacturer has no standard colour, provide gray semi-gloss finish as approved by the Consultant.

## 2.7 COMMUNICATION

- .1 Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- .2 Install new wiring and network devices as required to provide a complete and workable control network.
- .3 Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- .4 Internetwork operator interface and value passing shall be transparent to internetwork architecture.
- .5 An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
- .6 Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in the Contract Drawings and/or Contract Documents. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- .7 Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- .8 System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

## 2.8 OPERATOR INTERFACE SOFTWARE

- .1 General:
  - .1 The structure of the operator interface shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 simultaneous clients.
- .2 Graphical Display:
  - .1 Operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display all data using three-dimensional graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units, in International System of Units (SI). All information on any display shall be dynamically updated without any action by the user. Workstation shall allow user to change all field-resident BAS functions associated with the project, such as

- set-points, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
- .2 All displays and programming shall be generated and customized by the local BAS supplier and installer. Systems requiring factory development of graphics or programming of DDC logic shall be specifically prohibited.
  - .3 Binary objects shall be displayed as ACTIVE/INACTIVE/NULL or with customized text such as Hand-Off-Auto. Text shall be justified left, right or center as selected by the user. Also, binary objects shall be displayed as individual change-of-state graphic objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three graphic files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the object's commanded status when the graphic item is selected with the system mouse. Similarly, allow the workstation operator to toggle the binary object's status by selecting with the mouse, for example, a graphic of a switch or light, which then displays a different graphic such as an "ON" switch or lighted lamp. Additionally, binary objects shall be displayed as an animated graphic. Animated graphic objects shall be displayed as a sequence of multiple graphics to simulate motion. For example, when a pump is in the OFF condition, display a stationary graphic of the pump. When the operator selects the pump graphic with the mouse, the represented object's status is toggled and the graphic of the pump's impeller rotates in a time-based animation. The operator shall be able to click an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change graphic file assignment and create new and original graphics online. System shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.
  - .4 Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic. Each analog input object shall be assigned a minimum of five graphic files, each with high/low limits for automatic selection and display of these graphics. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling set-point. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the "increase" or "decrease" arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trend logs.
  - .5 Analog objects may also be assigned to a system graphic, where the color of the defined object changes based on the analog object's value. For example, graphical thermostat device served by a single control zone would change color with respect to the temperature of the zone or its deviation from set-point. All editing and area assignment shall be created or modified online using simple icon tools.
  - .6 A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label pushbuttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.



- .7 The BAS displays shall have the ability to link to content outside of the BAS system. Such content shall include but is not limited to: Launching external files in their native applications (for example, a Microsoft Word document) and launching a Web browser resolving to a specified Web address.
- .8 The BAS system shall have the ability to run multiple, concurrent displays windows showing continuously updated data.
- .9 The operator interface shall have the capability of allowing for zooming on maps that indicate the geospatial location of equipment. Enough resolution must be maintained at all levels.
- .3 Password Protection:
  - .1 Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.
  - .2 Each operator's terminal shall provide security for a minimum of 200 users. Each user shall have an individual User ID, Username, and Password. Entries shall be alphanumeric characters only and shall be case sensitive (except for User ID). User ID shall be 1–8 characters, Username shall be 1–29 characters, and Password shall be 4–8 characters long. Each system user shall be allowed individual assignment of only those control functions, menu items, and user specific system start display, as well as restricted access to discrete BACnet devices to which that user requires access. All passwords, Usernames, and access assignments shall be adjustable online at the operator's terminal. Users should have the capability to be assigned to specific user type "groups" that can share the same access levels to speed setup. Users who are members of multiple "groups" shall have the ability to activate/deactivate membership to those groups while using the BAS (without logout). Users shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.
  - .3 System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.
  - .4 The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.
- .4 Operator Activity Log:
  - .1 Operator Activity Log that tracks all operator changes and activities shall be included with system. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and by operation. Operator shall be able to print the Operator Activity log display.
  - .2 Log shall be gathered and archived to hard drive on operator's workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.
  - .3 Any displayed data that is changeable by the operator may be selected using the right mouse button and the operator activity log shall then be selectable on the screen. Selection of the operator activity log using this method shall show all operator changes of just that displayed data.
- .5 Scheduling:

- .1 Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.
  - .2 Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
  - .3 Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
  - .4 System shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting Schedule.
  - .5 Scheduling shall include optimum start based on outside air temperature, current heating/cooling set-points, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied set-point is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to set-point. User shall be able to set a limit for the maximum startup time allowed.
  - .6 Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule or launch the Schedule Wizard to allow the point to be scheduled.
- .6 Alarm Indication and Handling:
- .1 Operator's workstation shall provide audible, visual, printed, and email means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.
  - .2 System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.
  - .3 Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).
  - .4 System shall include an Alarm Wizard for set up of alarms. Wizard shall walk user through all steps necessary for alarm generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting alarm setup.
  - .5 Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or launch the Alarm Wizard to allow the creation of a new alarm.
- .7 Trend Log Information:
- .1 System server shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records

- shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the operator's workstation. Operator shall be able to view all trended records, both stored and archived. All trend log records shall be displayed in standard engineering units (SI).
- .2 Software that can graph the trend logged object data shall be included. Software shall be capable of creating two-axis (X, Y) graphs that display up to 10 object types at the same time in different colors. Graphs shall show object values relative to time. Each trend log shall support a custom scale setting for the graph view that is to be stored continuously. System shall be capable of trending on an interval determined by a polling rate, or change-of-value.
  - .3 Operator shall be able to change Trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
  - .4 System shall include a Trend Wizard for setup of logs. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic, and then selecting Trend logs from the displayed menu.
  - .5 System shall be capable of using Microsoft SQL as the system database.
  - .6 Any displayed data that is changeable by the operator may be selected using the right mouse button and the trend log shall then be selectable on the screen. Selection of the trend log using this method shall allow the viewing of the trend log view or launch the Trend log wizard to allow the creation of a new trend.
- .8 Energy Log Information:
- .1 System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units (SI).
  - .2 All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
  - .3 Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for energy consumption monitoring.
  - .4 System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.
- .9 Demand Limiting:
- .1 System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control set-points in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.

- .2 Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a "first off-first on" mode, and in the other the loads shall be shed/restored in a "first off-last on" (linear) fashion.
- .3 Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
- .4 Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.
- .10 Tenant Activity / Sub metering:
  - .1 System shall include program that monitors after-hours overrides by tenants, logs that data, and generates a bill based on usage and rate charged for each tenant space. Tenant Activity program shall be able to assign multiple zones, from a list of every zone connected to system, to a tenant. Every zone is monitored for after-hour override usage and that data logged in server. Operator may then generate a bill based on the usage for each tenant and the rate charged for any overtime use.
  - .2 Configuration shall include entry of the following information for use in logging and billing:
    - .3 Tenant's contact name and address
    - .4 One or multiple tenant zones that make up a total tenant space, including a separate billing rate for each separate zone
    - .5 Minimum and maximum values an event duration and event limit
    - .6 Property management information
    - .7 Overall billing rate
    - .8 Seasonal adjustments or surcharge to billing rate
    - .9 Billing notification type such including, but not limited to printer, file and email
    - .10 Billing form template
  - .11 Logging shall include recording the following information for each and every tenant event:
    - .1 Zone description
    - .2 Time the event begins
    - .3 Total override time
    - .4 Limits shall be applied to override time
  - .12 A tenant bill shall be generated for a specific period using all the entered configuration data and the logged data. User with appropriate security level shall be able to view and override billing information. User shall be able to select a billing period to view and be able to delete events from billing and edit a selected tenant activity event's override time.
- .11 Reports:
  - .1 System server shall be capable of periodically producing reports of trend logs, alarm history, device summary, energy logs, and override points. The frequency, content, and delivery shall be user adjustable.

- .2 All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.
- .12 Configuration and Setup:
  - .1 Provide means for operator to display and change system configuration. This shall include, but not be limited to system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.
- .13 Field Engineering Tools:
  - .1 Operator's workstation software shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares shall not be acceptable.
  - .2 User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
  - .3 Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
  - .4 Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
  - .5 Field engineering tool shall include Device Manager for detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller using the mouse.
  - .6 System shall automatically notify the user when a device that is not in the database is added to the network.
  - .7 System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.
  - .8 The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.
- .14 Web Interface:
  - .1 BAS supplier shall provide Web-based access to the system as part of standard installation. User must be able to access all displays of real-time data that are part of the BAS using a standard Web browser. Web browser shall tie into the network through owner-supplied Ethernet network connection. Web page host shall be a separate device that resides on the BAS BACnet network but is not the BAS server for the control system. BAS server must be a separate computer from the Web page host device to ensure data and system integrity. The Web page software shall not require a per-user licensing fee or annual fees. The Web page host must be able to

support on average 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

- .2 Web pages shall be automatically generated from the BAS displays that reside on the BAS server. User shall access Web page host through the network and shall initiate a Web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated shall be automatically installed on the Web page host for access using any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.
- .3 Web server shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.
- .4 Browser shall be standard version of Microsoft Internet Explorer v6.0 or later, Firefox v2.0 or later, Google Chrome v 36 or later, and Safari v2.0 or later (on Mac OS X). No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable, and the Web page host shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real-time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate Username and password.

## 2.9 DASHBOARD INTERFACE SOFTWARE

- .1 General:
  - .1 BAS supplier shall provide Niagara 4 Supervisor as the BAS dashboard that can support up to 150 simultaneous users as part of standard installation for viewing of system data on a display, kiosk or personal computer. The dashboard software shall reside on the BAS BACnet network and can share the BAS server for the control system.
- .2 Information Display:
  - .1 Support displaying up to 50 buildings.
  - .2 User shall be able to navigate by clicking on icons and/or navigate via a touchscreen without the need for any additional configuration.
  - .3 The dashboard shall support auto rotation of pages to support a display with no user interface (for example, touchscreen, mouse or keyboard). The pages to be displayed can be selected as a subset of all possible pages in the dashboard. The time to view each page and the order in which the pages are cycled through shall be configurable.
  - .4 The end user shall be able to compare measured data for one entity against measured data for a second entity.
  - .5 For each resource that is defined (for example: Water, Gas, etc.) one consumption page shall be used.
  - .6 The dashboard application shall include the following pages at a minimum:
    - .1 Home page;
    - .2 Consumption page;
    - .3 Summary page;
    - .4 Demand page;
    - .5 Green facts page; and,
    - .6 Weather page.
  - .7 The end user shall be able to view current data on one of the following time scales:

- .1 Cumulative data for today, displayed in hour increments;
- .2 Cumulative data for the current week, displayed in daily increments;
- .3 Cumulative data for the current month, displayed in daily increments; or,
- .4 Cumulative data for the current year, displayed in monthly increments.
- .8 The user shall be able to see:
  - .1 Today's data compared against the data for the same day last week;
  - .2 This week's data compared against the data for the same week last year;
  - .3 This month's data compared against the data for the same month last year; and,
  - .4 This year's data compared against the data for last year.
- .9 The user shall be able to view historical data in one of the following time scales:
  - .1 Complete data for yesterday, displayed in hourly increments;
  - .2 Complete data for last week, displayed in daily increments;
  - .3 Complete data for last month, displayed in daily increments; or,
  - .4 Complete data for last year, displayed in monthly increments.
- .3 Dashboard Data:
  - .1 The database for the dashboard shall be on the enterprise network and remotely hosted on a third-party network. The database shall be on-site to maintain security and privacy.
  - .2 Energy Dashboard data shall reside on site and shall remain in the BAS.
  - .3 The dashboard shall support Microsoft SQL database.
  - .4 The dashboard shall allow for the importation of external data via CSV file format.
- .4 Browser Technology:
  - .1 The dashboard shall support Microsoft Internet Explorer v9 or later, Firefox 3.6.15 or later, Safari 4 or later, and Google Chrome v 36 or later.
- .5 Dashboard Licensing:
  - .1 The Energy Dashboard shall utilize software licensing that will run in perpetuity, without the need for additional service and/or subscription fees.
  - .2 No dedicated server or embedded controller shall be needed to host energy dashboard software.
- .6 Configuration:
  - .1 End users shall be able to connect remotely (including dashboard location) to the system to make changes to the configuration using a browser.
  - .2 Energy Dashboard shall be maintainable by end-user staff with limited training and support common image files including JPEG and PNG.
  - .3 User generated/supplied content shall include foreground images, background images, text, and icons.
  - .4 Consumption pages for the resources defined—one (1) for each resource type for which s/he wishes to display consumption data. Consumption data is the total amount of a resource used over time, for example this is a kWh reading.
  - .5 The system designer shall be able to configure:

- .1 One or more home pages.
- .2 One or more summary consumption pages. This page shows the total consumption for each configured entity within the system and a total for the entire enterprise.
- .3 One or more current demand pages. This page shows the current demand for a given entity.
- .4 One or more green facts pages. This page is intended to inform the user of relevant environmental information.
- .5 One or more weather pages using weather station data from NOAA, Environment Canada, or Google.
- .6 Support ability to add additional capacity (more buildings, more meters) without the need for additional hardware.
- .7 Security:
  - .1 Dashboard shall have the ability to restrict data behind a firewall or within a demilitarized zone (DMZ).
  - .2 Dashboard application shall not allow the user to update the system data. For example, the user shall not be allowed to update the present-value of an analog-value.
  - .3 The dashboard shall require a user authorization via username and password to access the configuration screens.

## 2.10 OPERATOR WORKSTATION AND LAPTOP

- .1 General:
  - .1 PC based workstation and portable laptop shall reside on high-speed network with building controllers as shown on the Contract Drawings or detailed in the Specification. Each workstation, laptop and/or browser connected to the server shall be able to access all system information.
- .2 BACnet Conformance:
  - .1 Operator Workstation shall be approved by the BACnet Testing Laboratories (BTL) as meeting the BACnet Advanced Workstation requirements.
  - .2 Operator's workstation shall as a minimum support Point-to-Point (PTP) and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a native BACnet device. Operator's terminal shall comply with the requirements of a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
    - .3 Clock functional group;
    - .4 Event response functional group;
    - .5 Time master functional group, and,
    - .6 Device communications.
  - .3 Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
  - .4 Standard BACnet object types accessed by the workstation shall include as a minimum: Analog Value, Analog Input, Analog Output, Binary Value, Binary Input, Binary Output,



Calendar, Device, Event Enrollment, File, Notification Class, Program, and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

- .5 The operator's workstation shall comply with Annex J of the BACnet specification for IP connections. Must support remote connection to server using a thick client application. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs). Workstation shall support Foreign Device Registration to allow temporary workstation connection to IP network.

.6 Hardware:

- .1 Provide operator workstation(s) at locations as shown on the Contract Drawings or described in the sequence of operation.
- .2 As minimum, one operator workstation shall be provided for the Project.
- .3 Minimum computer requirements:
- .4 Dell Intel i7 4770 quad core processor, 3.4 GHz or better.
  - .1 8 GB RAM.
  - .2 500 GB hard drive.
  - .3 ATI Radeon HD graphics card with minimum 1GB DDR3.
  - .4 23" LCD monitor.
  - .5 10/100/1000 Ethernet network card.
  - .6 Keyboard, mouse, DVD-R/W, USB ports, etc.
  - .7 Microsoft Windows.
  - .8 Workstation shall be provided with dedicated UPS, minimum run time 15 minutes, minimum 500W and backup power.

2.11 **LOCAL OPERATOR INTERFACE (LOI)**

- .1 Local operator interface will be achieved by the portable laptop described in clause 2.10 above.

2.12 **BUILDING CONTROLLERS:**

- .1 General Requirements:
  - .1 BACnet Conformance:
    - .1 Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements and conform to BACnet v1.14.
    - .2 Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed in section 2.5.2.2. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
  - .2 Building controller shall be of modular construction such that various modules may be selected to fit the specific requirements of a given project. At a minimum, modules shall consist of a power supply module, a BACnet Ethernet or IP module, and a modem module for telephone communication. Those projects that require special

interfaces may use Modbus modules as needed. However, all Ethernet communications and all controllers—including central plant controllers, advanced application controllers and unitary controllers—supplied by BAS manufacturer shall utilize the BACnet protocol standard.

- .3 Modules shall be selected to fit the project application. Up to sixteen (16) modules shall be powered by a single power supply module. All modules shall be panel-mounted on DIN rail for ease of addition and shall be interconnected using a simple plug-in cable. A module in the middle shall be replaceable without removing any other modules.
- .4 All modules shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller. The software program implementing these strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a WAN or downloaded through remote communications shall not be acceptable. Changing global strategies using firmware changes shall also be unacceptable.
- .5 Programming shall be object-oriented using control function blocks, and support DDC functions, 1500 Analog Values and Binary Values. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.
- .6 Building controllers capable of routing Ethernet communication to LAN must have a multi-processor or multi-core architecture. The additional core/processor must be dedicated to processing the BACnet communication processes, allowing the primary to be dedicated to logical processing.
- .7 Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.
- .8 Controller shall have enough memory to ensure high performance and data reliability. Battery or capacitor shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Backup shall maintain real-time clock functions for a minimum of 72 hours.
- .9 Global control algorithms and automated control functions shall execute using 32-bit processor.
- .10 HMI Display:
  - .1 Building controllers shall have a compatible, touch-screen HMI panel that will allow for quick viewing of controller points, schedules and alarms.
  - .2 HMI panel shall be capability of being powered directly by building controller and will not require an additional power supply.
  - .3 HMI panel shall be mountable either on the DIN rail or on the door of the panel for easy access.
- .11 Schedules:
  - .1 Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.
  - .2 Building controller modules shall provide normal 7-day scheduling, holiday scheduling and event scheduling.
- .12 Logging Capabilities:

- .1 Each building controller shall log as minimum 500 individual trend logs. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
- .2 Logs may be viewed both on-site and off-site using WAN and remote communication.
- .3 Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.
- .13 Alarm Generation:
  - .1 Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
  - .2 Each alarm may be dialed out as noted in section 2.3.6.
  - .3 Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
  - .4 Controller shall be able to handle up to 320 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.
- .14 Demand Limiting:
  - .1 Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
  - .2 Load shedding programs in building controller modules shall operate as defined in sequence of operation and or as per Operator scheduling or override.
- .15 Tenant Activity Logging:
  - .1 Tenant Activity logging shall be supported by a building controller module. Each independent module shall support a minimum of 380 zones.
- .2 Ethernet Modules:
  - .1 Ethernet Module shall support every function as listed under the General Requirements of this section and the following:
  - .2 All communication with operator's workstation and all application controllers shall be through BACnet. Building controller Ethernet module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet module shall also route messages from all other building controller modules onto the BACnet Ethernet network.
  - .3 BACnet Conformance:
    - .1 Ethernet module shall, as a minimum, support Ethernet BACnet LAN. It shall communicate directly using these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Global controller shall be approved by the BACnet Testing Laboratory (BTL) as meeting the BACnet Building Controller requirements.
    - .2 All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

- .3 The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on WANs and CANs and function as a BACnet Broadcast Management Device (BBMD).
- .3 BACnet IP
  - .1 The building controller shall have capability to comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).
  - .2 Must support interoperability on WANs and campus area networks (CANs), and function as a BACnet Broadcast Management Device (BBMD).
  - .3 Each controller shall support at a minimum 128 BBMD entries.
  - .4 BBMD management architecture shall support 3,000 subnets at a minimum.
  - .5 Shall support BACnet Network Address Translation.
  - .6 All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- .4 Expansion Ports
  - .1 Controller shall support two (2) expansion ports.
  - .2 Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.
  - .3 Expansion cards that mate to the expansion ports shall include:
  - .4 Dual port EIA-485 card.
- .5 Power Supply Modules:
  - .1 Power supply module shall power up to seven building controller modules. Input for power shall accept between 17~30VAC, 47~65Hz.
  - .2 Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.
  - .3 Upon restoration of a lost power source the controller shall automatically resume full operation without manual intervention. The controllers shall incorporate start sequences to ensure a power spike does not result.
- .6 Controller shall operate in the following environmental conditions:
  - .1 -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with optional battery.
  - .2 0 to 95% relative humidity (RH), non-condensing.

## 2.13 FIELD LEVEL CONTROLLERS

- .1 Provide one or more native BACnet application controllers for each air handler and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller through Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical

programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

.2 BACnet Conformance:

- .1 Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.
- .2 Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- .3 Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

.3 Application controllers shall include universal inputs with 12-bit resolution that accept 20K thermistors, 0–10VDC, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support 0–10VDC. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

.4 All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller minimum of once per second and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal.

.5 Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

## 2.14 UNITARY EQUIPMENT CONTROLLERS

.1 Provide one native BACnet application controller for each piece of unitary mechanical equipment (Fan Coils, Heat Pumps, AC Units, VAV box, reheat coils, fans, etc.) that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

.2 BACnet Conformance:

- .1 Application controllers shall, as a minimum, support Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. They shall communicate directly using this BACnet LAN. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:
  - .1 Files Functional Group
  - .2 Reinitialize Functional Group
  - .3 Device Communications Functional Group

- .2 Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- .3 Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- .3 Application controllers shall include universal inputs with 10-bit resolution that can accept 20K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall include binary outputs on board with analog outputs as needed.
- .4 All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.
- .5 Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.
- .6 On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through operator's workstation, portable computers, or special hand-held field tools.
- .7 Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator's workstation.:

#### 2.15 HVAC CONTROL PANELS (HCP)

- .1 The maximum width of the panel is to be 900 mm (36 inches), unless space restrictions require a single larger panel.
- .2 All wiring within the panel is to be in Panduit. Field wiring is to be terminated at a single terminal strip located on one side of the panel.
- .3 A single 120-volt, 20 amp feeder shall serve each HCP, unless otherwise indicated in the Contract Documents. The 120-volt feed shall be brought into a dedicated power panel (HCP Power Panel) housing switches, power outlet and 120 to 24-volt transformers. The HCP panel shall be constructed for low voltage (class II) components only. Any non-class II components or wiring shall be contained within the HCP Power Panel.
- .4 Each DDC Controller enclosure shall have a standard switched 120/1/60 15A duplex AC power receptacle located within the enclosure to provide power for test equipment, operation, communication devices, etc.
- .5 Uninterruptible Power Supply (UPS)

- .1 At each HVAC Control System panel, provide an onboard UPS with a minimum 12-hour battery life. The UPS shall have the following features:
  - .1 Power Input 120VAC.
  - .2 Surge protection.
  - .3 Audible alarm on low battery power.
  - .4 Wiring fault indicator.
  - .5 Power indicator.
  - .6 Replace Battery indicator.
  - .7 Overload indicator
  - .8 DB9 RS232, USB port for interface.
- .6 Provide a 120V/24V fused transformer(s) located within the control panel to power all devices requiring same.
  - .1 Output to match equipment current and voltage requirements.
  - .2 Units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes.
  - .3 Units shall have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure.
  - .4 Units shall be capable of operation between 0°C and 50°C (32°F and 120°F). EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
  - .5 Power Line Filtering:
    - .1 Shall be provided to afford internal or external transient voltage and surge suppression for workstations and control modules.
      - .1 Surge Protection:
        - .1 Dielectric strength of 1000 V minimum.
        - .2 Response time of 10 nanoseconds or less.
        - .3 Transverse mode noise attenuation of 65 dB or greater.
        - .4 Common mode noise attenuation of 150 dB or greater at 40 -100 Hz.
- .7 HCP Contents:
  - .1 HVAC Control System: DDC controllers, 120V receptacle, on/off switch to isolate panel/receptacle power, fuses, control relays, control switches, transformers, display screens, keypads, and other devices necessary for system. Flush mount display screens and keypads on front panel face and provide enough gaskets/seals to preserve the panel rating.
  - .2 Non DDC HVAC Control System: As appropriate to the application but may include set point adjustment dials, gauges, receiver controllers, manual timers, time clocks, microprocessor control modules, electronic indication relays, pilot lights, alarm lights, selector switches. Indicating lights and similar visual display components are to be door mounted. Flush mount pilot lights, display screens and keypads on front panel face.
- .8 HCP Construction:

- .1 Construct each HCP to conform to NEMA 250 rating as indicated in the Schedule below, except where indicated otherwise in the Contract Documents:

HVAC Control Panel (HCP) NEMA 250 Construction Schedule	
Location	NEMA 250 Type
Indoors (incl. indoor AHUs)	2
Outdoors (incl. outdoor AHUs)	4x

- .2 Metal enclosures are to accommodate secure conduit fittings and protect against electrical transients.
- .3 Hinged front door with locking handle (or locking latch) and key. All panel locks are to be common keyed.
- .4 Identify gauges and control devices on the panel face with engraved lamacoid labels with an engraved white-black-white laminated plastic nameplate indicating the function of the instrument. Relays and terminal blocks within the panel shall be identified with plastic slip on wire markers.
- .5 Identify HVAC systems controlled by the controller on the panel face with engraved lamacoid labels with an engraved white-black-white laminated plastic nameplate. Relays and terminal blocks within the panel shall be identified with plastic slip on wire markers.
- .6 All field control and power wiring, panel wiring, equipment terminations or field wiring joints shall be identified by tubular sleeve heat shrink-type or non heat shrink-type markers as follows:
- .1 Wire markers shall be white with black print.
  - .2 Properly sized as per the manufacture's recommendations for the type and size of wire/cable.
  - .3 Labeling shall agree with manufacturer's equipment drawings, control drawings and panel directories.
  - .4 Shall be CSA/ULC approved for the intended use.
  - .5 Wire markers shall be Brady "PermaSleeve" wire markers B-319 or B-321 or preapproved equivalent.
  - .6 Handwritten or adhesive book numbers/letters shall not be acceptable.
  - .7 Indicating lights on the panel cover shall be minimum 20 mm (3/4-inch) diameter Allen Bradley oil tight push to test lights, with 24 VAC replaceable light bulbs.
- .9 Panel Listing: Panel shall bear a CSA listing mark.
- .10 Control Devices:
- .1 Mount inside HCP unless otherwise indicated in the Contract Documents.
  - .2 Prewired internally.
  - .3 Terminate wires leaving HCP at separately numbered terminal strips (one terminal pair per circuit).
  - .4 Furnish individual connectors for every item of mechanical equipment, integral and remote pilot lights, or other devices described for each panel.
  - .5 Identify wires by colour coding or numerical tags at both ends.



- .6 Wire control devices without splices to the terminal strip.
- .7 Furnish integral circuit protection for panel mounted control devices.
- .11 Terminal Blocks:
  - .1 One piece molded plastic blocks with screw type terminals and barriers rated for 600 volts.
  - .2 Double sided and supplied with removable covers to prevent accidental contact with live circuits.
  - .3 Furnish permanent, legible identification, clearly visible with the protective cover removed.
  - .4 Terminate wires at terminal blocks with crimp type, preinsulated, ring tongue lugs.
  - .5 Size lugs for terminal block screws and for the number and size of wires terminated.
  - .6 Provide screwdriver access for blade width of a minimum of 5 mm for Klein 601 Series screwdrivers. Terminals requiring use of special screwdrivers are not acceptable.
- .12 Miscellaneous Accessories:
  - .1 Furnish panel as built electrical layout diagrams, secured to the inside of panel door, or enclosed in plastic jackets placed inside each panel.
  - .2 Provide non-destructible labeling on the inside surface of panel door to indicate the source (panel and circuit breaker number) of power to the panel.
  - .3 Install plastic or stick on labels on interior control devices to identify them in conjunction with control schematics.
  - .4 Provide one spare set of fuses for each fuse type in a fuse holder mounted inside the panel. (Alternate: Provide ABB S200U-K series miniature circuit breakers, or approved equal, mounted on din rail inside of the panel. Provide one circuit breaker for every 4A class II circuit.)
  - .5 Provide a metal document holder inside the panel.
  - .6 For outdoor panels provide a thermostatic heater to prevent condensation/ corrosion inside the panels.

#### 2.16 CONTROL VALVES (PRESSURE INDEPENDENT):

- .1 General: Provide 2-way pressure independent valves or 3-way valves, to suit the application and flow media, as shown on the Contract Drawings. 2-position valves (fully open or fully closed) are not required to be pressure independent.
  - .1 Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of the piping system, unless otherwise indicated.
  - .2 The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory, or shall be provided with universal mounting plate to allow installation of actuators, meeting system electrical and valve torque requirements.
  - .3 The valve shall be fit with a fail-safe electric rotary actuator. Fail safe shall be provided by spring return or by internal power supply shall be integral to actuator and designed for one full stroke at the rated torque in the absences of main power. No physical change to the build or construction of the actuator shall be needed to achieve the change in fail safe build.

- .4 Selection of actuator is to be based on the requirements of the applications and installation location. Actuator shall include manual override, programmable limit switches and double o-ring seal. All valves or dampers marked as NC (normally closed) shall be FS (fail safe) as well, unless otherwise stated or required in the sequence of operation.
- .5 The control valve shall accurately control the flow from 0% to 100% full rated flow with an equal percentage flow characteristic.
- .6 Each control valve shall deviate no more than  $\pm 5\%$  through the operating pressure range.
- .7 The manufacturer shall warrant all components for a period of 5 years from the date of production.
- .2 Calibrated balancing valves and/or automatic flow-control valves shall not be required where pressure independent controls valves are installed.
- .3 Provide control valves that are properly sized and selected in accordance with the load requirements and characteristics of the systems to which they are applied.
- .4 Valves are to be plug, ball, and/or butterfly, as required by the specific application.
- .5 Pressure Drop:
  - .1 Two-way Modulating:
    - .1 Non-Radiation: Pressure drop equal to the pressure drop through the coil or 35 kPa (5 psi), whichever is greater.
    - .2 Radiation: Pressure drop equal to 7 kPa (1 psi).
  - .2 Three-way Modulating:
    - .1 Non-Radiation: Pressure drop equal to the pressure drop through the coil or 35 kPa (5 psi), whichever is greater.
    - .2 Radiation: Pressure drop equal to 7 kPa (1 psi).
- .6 Two position valves shall be line size with full ports.
- .7 Leakage: ANSI Class IV
- .8 Acceptable Manufacturers: Belimo Air Controls Inc., Johnson Controls Inc., Siemens Canada Inc., or Honeywell International Inc.
- .9 13 mm to 50 mm (0.5" to 2") Valves:
  - .1 Forged brass body with NPT screw fittings. Minimum valve body rating to be ANSI 250 class.
  - .2 1379 kPa (200 psi) close-off pressure rating.
  - .3 Terminal valves shall have chrome plated brass ball and stem (water only). All other valves shall have stainless steel trim.
  - .4 Provide 100:1 rangeability.
  - .5 Provide equal percentage characteristics for all modulating services.
- .10 65 mm to 150 mm (2.5" to 6") Valves:
  - .1 Brass body with iron flanges or cast iron. Minimum valve body rating to be ANSI 150. Provide higher body ratings as required for the water systems when applicable.
  - .2 690 kPa (100 psi) close-off pressure rating.
  - .3 Valves shall have stainless steel trim.

- .4 Provide 100:1 rangeability.
- .5 Provide equal percentage characteristics for all modulating services.
- .11 Valve Actuators:
  - .1 Control Signal: Electronic action, compatible with controller outputs.
  - .2 Floating control signal is not acceptable.
  - .3 Operating Time: Maximum 120 seconds throughout the full rotation.
  - .4 Mounting: Corrosion resistant hardware.
  - .5 Stall Protection: Electronic overload or digital rotation sensing.
  - .6 Fail safe: Non-spring return for radiation and terminal reheat coils; spring return or internal power supply for others. Spring returns to normal position within 15 seconds.
  - .7 Manual Override: Crank type. External gear release for non-spring return actuators.
  - .8 Position Indicator: Provide, indicate valve open and closed positions.
  - .9 Close-off Pressure:
    - .1 Two-way: 150% of total system head.
    - .2 Three-way: 300% of the pressure differential between ports A and B at design flow, or 100% of total system head.
  - .10 General purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use:

## 2.17 CONTROL DAMPERS

- .1 General:
  - .1 Specification applies to control dampers, except those specified to be furnished with equipment.
  - .2 Furnish opposed blade type for proportional action and parallel blade type for two position action, except where indicated otherwise in the Contract Documents.
  - .3 T.A. Morrison & Co. Inc. "TAMCO", Alumavent Inc. or approved equivalent, 100 mm (4 inches) deep, flanged aluminum control dampers with AMCA certified maximum leakage through a 1.2 m x 1.2 m (48 inch x 48 inch) damper.
  - .4 The damper shall be fit with a fail-safe electric rotary actuator. Fail safe shall be provided by spring return or by internal power supply shall be integral to actuator and designed for one full stroke at the rated torque in the absences of main power. No physical change to the build or construction of the actuator shall be needed to achieve the change in fail safe build. Selection of actuator is to be based on the requirements of the applications and installation location. Actuator shall include manual override, programmable limit switches and double o-ring seal. All valves or dampers marked as NC (normally closed) shall be FS (fail safe) as well, unless otherwise stated or required in the sequence of operation.
  - .5 Provide mounting installation details and structural reinforcement and/or supports to meet system operational pressures and air flow velocities and /or wind loads for all building envelope installed dampers, and actuator type.
- .2 Standard Damper: Tamco Series 1500, Alumavent Series 3165 dampers or approved equivalent complete with:
  - .1 Leakage through a 1.2 m x 1.2 m (48 inch x 48 inch) damper of 19 L/s/m<sup>2</sup> (3.7 CFM/square feet) against 1 kPa (4 inch w.g.) differential static pressure. Standard air leakage data is certified under the AMCA Certified Ratings Program.

- .2 Extruded 6063T5 aluminum frame and blades, each with an integral slot to receive a gasket.
- .3 Aluminum end caps press fitted to blade ends.
- .4 Extruded silicone frame and blade gaskets secured in an integral slot within the aluminum extrusions.
- .5 Slip-proof aluminum and corrosion resistant zinc-plated steel linkage concealed in the frame, equipped with self-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on the hexagonal or square blade pin and rotating in a polycarbonate outer bearing inserted in the frame.
- .3 Insulated Damper: Tamco Series 9000, Alumavent Series 3965 dampers or approved equivalent complete with:
  - .1 Leakage through a 1.2 m x 1.2 m (48 inch x 48 inch) damper of 20.92 L/s/m<sup>2</sup> (4.12 CFM/square feet) against 1 kPa (4 inch w.g.) differential static pressure. Standard air leakage data is certified under the AMCA Certified Ratings Program.
  - .2 Extruded 6063T5 aluminum frame and blades, each with an integral slot to receive a gasket.
  - .3 Blades are thermally broken and internally insulated with expanded polyurethane foam.
  - .4 Extruded TPE (Santoprene) side seals and extruded EPDM blade gaskets secured in an integral slot within the aluminum extrusions.
  - .5 Slip-proof aluminum and corrosion resistant zinc-plated steel linkage concealed in the frame, equipped with self-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on the hexagonal blade or square pin and rotating in a polycarbonate outer bearing inserted in the frame.
- .4 Acceptable manufacturers are:
  - .1 T.A. Morrison & Co. Inc. "TAMCO", Alumavent Inc, EB Air, Greenheck, American Warming and Ventilating

## 2.18 CONTROL DAMPER ACTUATORS:

- .1 The damper shall be fit with a fail-safe electric rotary actuator. Fail safe shall be provided by spring return or by internal power supply shall be integral to actuator and designed for one full stroke at the rated torque in the absences of main power. No physical change to the build or construction of the actuator shall be needed to achieve the change in fail safe build. Selection of actuator is to be based on the requirements of the applications and installation location. Actuator shall include manual override, programmable limit switches and double o-ring seal. All valves or dampers marked as NC (normally closed) shall be FS (fail safe) as well, unless otherwise stated or required in the sequence of operation.
- .2 Drawings and Control Diagrams indicate only one damper motor for each motorized damper (MOD).
- .3 Select actual quantity of motors required to operate each damper in accordance with the size of damper provided.
- .4 Coordinate exact quantity of damper motors with electrical Work to ensure that necessary wiring and conduit is provided for installation.
- .5 Provide operators for motorized dampers and motorized louvers for all cases where an operator is not supplied as part of a unit.
- .6 Operating Time: Maximum 120 seconds throughout the full rotation.
- .7 Angle of Rotation: Adjustable between 0° to 90°.

- .8 Stall protection: Mechanical or electronic.
- .9 Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.
- .10 Failsafe: Non-spring return for VAV terminals; spring return or internal power supply for other applications. Spring return to normal position within 15 seconds.
- .11 Provide quantity of actuators to ensure enough torque for the damper. Total actuator torque must be 20% above the calculated damper torque.
- .12 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
- .13 Manual Override: Crank type. External gear release for non-spring return actuators.
- .14 Provide UL555S listed damper actuators for all dampers used in smoke control.
- .15 Approved equivalent actuator manufacturers will be considered only if the two-position actuators proposed have two auxiliary contacts at least one of which shall be an adjustable (between 35 percent and 100 percent open) trip point. The second auxiliary contact will be used to provide feedback to the HVAC Control System for monitoring and alarming purposes. For modulating actuators provide actuator with 0-20mA feedback proportional to damper position. All actuators provided shall be from a single manufacturer.
- .16 Provide ample number of actuators and adequate power to overcome friction of damper linkage and air pressure acting on damper blades.
- .17 Damper operators are to be selected to provide 20% excess torque for the application. Provide multiple damper operators as required. It is the responsibility of the Contractor under this Section to determine and include for the total number of operators required.
- .18 Unless otherwise shown on the Drawings, operators to be provided and set up such that all return air dampers are normally open (fail open) and exhaust and outdoor air dampers fail normally closed (fail closed).
- .19 General purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use.
- .20 Acceptable Manufacturers: Belimo Air Controls Inc., Johnson Controls Inc., Siemens Canada Inc., or Honeywell International Inc.

#### 2.19 AUXILIARY CONTROL DEVICES:

- .1 Intelligent Room Sensor
  - .1 Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit and allow occupant to raise and lower setpoint and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
  - .2 The intelligent room sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in degrees Fahrenheit or Centigrade.
  - .3 Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.

- .4 Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.
- .2 Temperature Sensors:
  - .1 General Requirements:
    - .1 Temperature sensors shall be of the resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 20,000 ohm thermistor.
  - .2 Space Temperature Sensors:
    - .1 For installation throughout the facility unless otherwise noted.
    - .2 Reporting accuracy  $\pm 1^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{F}$ ), control accuracy  $\pm 1^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{F}$ ).
  - .3 Space Temperature Sensors with Adjustable Set-Point, Override and Display:
    - .1 Keypad or slider for temperature set-point adjustment.
    - .2 LED display.
    - .3 Timed override request push button with LED status for activation of after-hours operation.
    - .4 For installation only where indicated on drawings, controls diagrams or sequences of operations.
    - .5 BAS integrated.
  - .4 Covers for Wall Mount Sensors:
    - .1 Overrides: Exposed set point adjustment and override button.
    - .2 Communication Port: For communication between Portable Operator Terminals and ASC controllers.
  - .5 Averaging Temperature Sensors:
    - .1 Minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
    - .2 Provide multiple sensors where single averaging element is unable to be positioned to provide complete duct or plenum traverse.
    - .3 Reporting accuracy  $\pm 0.5^{\circ}\text{C}$  ( $\pm 1^{\circ}\text{F}$ ), control accuracy  $\pm 0.5^{\circ}\text{C}$  ( $\pm 1^{\circ}\text{F}$ ).
  - .6 Outside Air Temperature Sensors:
    - .1 Outside air temperature sensors shall be designed to withstand the environmental conditions to which they will be exposed.
    - .2 The sensors shall be provided with a solar shield.
    - .3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
    - .4 Reporting accuracy  $\pm 0.5^{\circ}\text{C}$  ( $\pm 1^{\circ}\text{F}$ ), control accuracy  $\pm 0.5^{\circ}\text{C}$  ( $\pm 1^{\circ}\text{F}$ ).
  - .7 Duct Temperature Sensors:
    - .1 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
    - .2 Probe length shall be no less than 1/3 of the duct width or diameter.

- .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
- .4 Reporting accuracy  $\pm 1^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{F}$ ), control accuracy  $\pm 1^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{F}$ ).
- .8 Thermowells:
  - .1 Brass or Type 316 stainless steel suitable for the application.
  - .2 Heat transfer compound compatible with sensing element.
- .3 Guards for Sensors and Thermostats:
  - .1 Materials: Heavy gauge steel.
- .4 Relative Humidity Sensors:
  - .1 Sensors shall have a minimum range of 10% to 90% with an accuracy of  $\pm 2\%$  RH.
  - .2 Outdoor sensors shall be suitable for a temperature range of  $-40^{\circ}\text{C}$  to  $75^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $167^{\circ}\text{F}$ ). Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure.
  - .3 Humidity sensor drift shall not exceed 1% of full scale per year.
  - .4 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
  - .5 Sensors shall be calibrated to NIST standards.
- .5 Binary Temperature Devices:
  - .1 Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed set-point adjustment,  $13^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ( $55^{\circ}\text{F}$  to  $85^{\circ}\text{F}$ ) set point range,  $1^{\circ}\text{C}$  ( $2^{\circ}\text{F}$ ) maximum differential, and vented ABS plastic cover.
  - .2 Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed set-point adjustment,  $13^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  ( $55^{\circ}\text{F}$  to  $85^{\circ}\text{F}$ ) set-point range,  $1^{\circ}\text{C}$  ( $2^{\circ}\text{F}$ ) maximum differential, and vented ABS plastic cover.
  - .3 Low-limit thermostats: Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only. Limit shall have auxiliary contact for connection to BAS. Thermostat set point range shall be  $-1^{\circ}\text{C}$  to  $13^{\circ}\text{C}$  ( $30^{\circ}\text{F}$  to  $50^{\circ}\text{F}$ ) and set to  $1.67^{\circ}\text{C}$  ( $35^{\circ}\text{F}$ ).
  - .4 High-limit thermostats: High-limit airstream thermostats shall be UL listed, vapor pressure type. The high-limit thermostat shall be manual reset only. Thermostat set point range shall be  $38^{\circ}\text{C}$  to  $66^{\circ}\text{C}$  ( $100^{\circ}\text{F}$  to  $150^{\circ}\text{F}$ ) and set to  $57^{\circ}\text{C}$  ( $135^{\circ}\text{F}$ ).
- .6 Relays:
  - .1 Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
  - .2 Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable  $\pm 200\%$  (minimum) from set point shown on the Contract Drawings. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.
- .7 Override Timers:

- .1 Override timers shall be spring-wound or electronic type, UL Listed, with contact rating and configuration as required by application. Provide 0 to 1 hour override adjustment unless otherwise specified in the Contract Documents. Timer shall be suitable for flush mounting on control panel face or flush mounted on a single gang electrical box.
- .8 Transformers:
  - .1 AC voltage transformers shall be UL/CSA Recognized, 600 VAC rated, complete with built-in fuse protection.
  - .2 Transformers shall be suitable for ambient temperatures of 4°C to 55°C (40°F to 130°F) and shall provide  $\pm 0.5\%$  accuracy at 24 VAC and a 5 VA load.
  - .3 Windings (except for terminals) shall be completely enclosed with metal or plastic material.
- .9 Current Switches:
  - .1 Current-operated switches shall be self-powered, solid-state with adjustable trip current with LED status indicator and insulation rating of 600 VAC. The switches shall be selected to match the current of the application and output requirements of the DDC system.
- .10 Pressure Transducers:
  - .1 Transducer shall have linear output signal. Zero and span shall be field adjustable. Accurate to  $\pm 1\%$ .
  - .2 Transducer sensing elements shall be capacitance sensing type and able to withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
  - .3 Water pressure transducer shall have stainless steel diaphragm construction, minimum proof pressure of 1,034 kPa (150 psi). Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
  - .4 Water differential pressure transducer shall have stainless steel diaphragm construction, minimum proof pressure of 1,034 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2,068 kPa (300 psi). Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.
- .11 Pressure Switches:
  - .1 Differential pressure type switches (air or water service) shall be UL listed, single pole, double throw (SPDT) snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as shown on the Contract Drawings.
- .12 CO<sub>2</sub> Sensors
  - .1 Sensors shall employ non-dispersive infrared technology (NDIR).
  - .2 Accuracy shall be  $\pm 5$  ppm over 0-1500 ppm range with response time of less than 1 minute.
  - .3 Sensor shall have 4-20 mA outputs at 20-30 VDC/AC power voltage.
  - .4 Sensors shall have operating range of 0°C (32°F) to 40°C
- .13 Gas Detection System
  - .1 Gas Detection Controller



- .1 Use: Centralized gas detection monitoring with real-time gas reading, selective alarm activation.
- .2 Enclosure: MENA 3 for indoor and NEMA 4X for outdoor.
- .3 Power Requirement: 90-240VAC, 17-27 Vac, 24-38 Vdc.
- .4 Network: Modbus, BACnet
- .5 Alarm Levels: Adjustable, LOW, MID and HIGH alarm set-points for each channel
- .6 Outputs: Four SPDT relays (alarms and/or fault) dry contact relays rated 5 amps @ 240 VAC or to suit the application.
- .7 Buzzer, rated 90 dB @ 30 cm
- .8 Display: LCD display, with LED indicators, e.g. "POWER", "STATUS 1, 2 and 3" and "FAULT"
- .9 Operating Humidity Range: minimum range 15-90% RH, non-condensing.
- .10 Operating Temperature Range: minimum range -20 to 40°C.
- .11 Certifications: CAN/CSA C22.2.
- .12 Make and Model: Honeywell 301C, C.E.T. FCS-8, or equivalent.
- .2 Wired or Stand-Alone Gas Transmitter:
  - .1 Use: Wall mounted, wired gas detector transmitter used in conjunction with controller.
  - .2 Power Requirement: 12-27 Vac, 16-30 Vdc.
  - .3 Network: Modbus, BACnet
  - .4 Display: LCD display.
  - .5 Visual Indicators: Alarm or fault conditions to be displayed on LCD display or LED lights
  - .6 Audible Alarm: Remote strobe and horn rated 99 dB @ 3 m
  - .7 Relay Output: One SPDT relay, dry contact relays rated 2 amps @ 30 VAC or to suit the application.
  - .8 Sensing Technology: Electrochemical sensor or catalytic for combustibles (internal or remote) or solid state for refrigerants (internal) or PID TVOC (remote)
  - .9 Accuracy: +/- 5%
  - .10 Pre-calibrated sensors: Provide calibration certificates.
  - .11 Detection Range: Carbon Monoxide = 0 - 200 ppm; Nitrogen Dioxide (NO<sub>2</sub>) = 0-10 ppm; Oxygen = (0 - 25% volume); Combustibles = 0-100% LEL;
  - .12 Certified to: CAN/CSA C22.2
  - .13 Provide additional cUL/ CSA strobe and horn combination to suit installation area full coverage.
  - .14 Make and Model: Honeywell E3 Point sensors, C.E.T. LPT or ART, or equivalent.
- .14 CH<sub>4</sub> detection system:

- .1 RS485 MODBUS for use with remotely mounted flammable gas sensors 705 and 705HT or equivalent.
- .2 Incorporating a transmitter with local display and remote mounted sensor, fully configurable with a wide range integral and remote sensors
- .3 Input Voltage Range: 16 to 32Vdc (24Vdc nominal)
- .4 Max Power Consumption: 5W
- .5 Maximum inrush current = 800mA at 24VDC
- .6 Relays: One SPDT dry contact relay, rated 30 volts, 2 amps max, or to suit application.
- .7 Communication: RS485, Modbus
- .8 Material: Housing: ABS / Polycarbonate or Epoxy painted aluminum.
- .9 Certification: CAN/CSA C22.2.
- .10 Operating temperature: -20°C to +40°C or to suit application
- .11 Operating humidity: Continuous 20-90%RH (noncondensing).
- .12 Sensor shall be available for remote monitoring configuration at a distance of up to 15 M from the transmitter with the remote junction box UL/CSA listed as required
- .13 Non-intrusive calibration: sensor/transmitters can be calibrated without opening any enclosures. Calibration shall be completed via the local display utilizing magnetic switches. The device shall not use clamp on devices or wireless remote controls to perform calibration or configuration operations. Calibration of the sensor shall be so that only one person is required to complete calibration. Successful calibration must be visually indicated via the unit LCD
- .14 Make and Model: Honeywell Sencepoint XCD, C.E.T. LPT sensors or equivalent.
- .15 Refrigerant detection system:
  - .1 Provide all labor, materials, products, equipment and service to supply and install a refrigerant detection and control system
  - .2 Units shall be certified to ULc and CSA standards.
  - .3 The system shall include, but not be limited to, the following
    - .1 Future expandability
    - .2 Display of refrigerant gas concentration
    - .3 Ability to modify alarm set points
    - .4 Interlocking with emergency system shut down
    - .5 Automatic and manual fan start/stop
    - .6 Display of alarm status
  - .4 Main controller/ expansion module:
    - .1 The expansion module shall be installed inside the mechanical room and be capable of communicating digitally with the networked sensors through RS-485 Modbus communication or analog signal(4-20mA). The system shall operate on 24Vac 2A max. The sensor must have at least one relay output rated 30 volts, 2 amps. The main controller must have at least four relay outputs rated 5 amps @ 240 VAC., or to suit application.

- .2 The expansion module must provide all the functionalities necessary to comply with current ASHRAE 15 guidelines and CSA B-52 Mechanical Codes. This includes a key for manual fan start/ stop operation, a silence key to acknowledge RFSA 105db horn (audible alarm operation will automatically reset and sound again at the next alarm occurrence ), a RED strobe on top of the unit as a visual alarm and (2) inputs for the "EMBG" break glass switch for EMERGENCY shutdown.
- .3 The Controller/expansion module will indicate the exact concentration of refrigerant gas and the refrigerant gas detected. The controller shall continuously display the specified refrigerant concentration of each sensor via a scrolling LCD screen. The LCD screen will indicate multiple alarm levels for each sensing point.
- .4 The alarm 'Low level' relay shall be energized, and the first alarm shall be initiated when the refrigerant gas concentration reaches or exceeds the programmed level 1. Alarm 'Low level' shall start the mechanical room ventilation equipment and shutdown any combustion equipment in the same mechanical room. Provide hardwired interface and BAS interface. The Alarm 'Mid Level' relay shall be energized, and the second alarm shall be initiated when the refrigerant concentration levels reach or exceed the programmed level 2. Alarm 'Low level' shall energize the red horn strobe of the controller or a remote alarm horn strobe.
- .5 The LED indicators shall also provide visual feedback in the following manner:
  - .1 Normal Operation: Green LED
  - .2 Alarm Level A: Red LED
  - .3 Alarm Level B: Red LED
  - .4 Failure: Yellow LED
  - .5 TX: Yellow LED

OR (dependent on device)

Alarm	LED	Description
.7 Low-Alarm alarm	Status 1 is Red	At least one channel is in low
.8 Mid-Alarm alarm	Status 1 & 2 are Red	At least one channel is in mid
.9 Hi-Alarm high alarm	Status 1, 2 & 3 are Red	At least one channel is in
.10 Fault Fault	Fault is Red	At least one channel is in
- .6 The standard three high/low alarm levels will be complemented with a fault relay.
- .7 The Controller/expansion module must provide an individual 4 -20mA output per refrigerant sensor (up to twenty) for BAS compatibility.
- .5 Remote annunciator entrance Panel:
  - .1 The remote annunciator panel must be installed outside the mechanical room at the main entrance door and be capable of communicating digitally with the Controller/expansion module, and other annunciator modules and accessories.

- .2 The Remote Annunciator Panel will manage relays at fully programmable alarm levels.
- .3 The remote panel must provide all the functionalities necessary to comply with Current ASHRAE 15 and CSA B-52 Mechanical Codes.
  - .1 Red Strobe & horn
    - .1 Manual push button to activate ventilation "purge" / emergency mode. This push button function shall be latching type. Turning off (disable) the ventilation shall be done by the authorized personnel/ BAS Operator through BAS system or manually at the panel (key).
    - .2 An additional, manual mode shall be provided inside the mechanical room. Allowing ventilation "purge" / emergency mode start or stop by the personnel inside the mechanical room.
- .4 The Remote annunciator panel will indicate the exact concentration of refrigerant gas and the refrigerant gas detected from each sensor. The LCD display screen will indicate multiple alarm levels for each sensing point. The annunciator panel will also provide visual feedback in the following manner:
  - .1 Normal Operation
  - .2 Alarm Level A
  - .3 Alarm Level B
  - .4 Failure
  - .5 additional strobe and horn units are to be provided, refer to item #7.
- .6 Infrared refrigerant gas sensor:
  - .1 The sensor will be powered by the 301EM-RFSA Controller/expansion module. The detector shall be of diffusion type with no internal sample pump or filter maintenance required. Refrigerant gas will enter the infrared gas detection chamber according to the diffusion principle. Infrared sensing technology will detect the refrigerant gas by sensing the absorption rate of a specific bandwidth of light.
  - .2 The gas sensor will have resolution levels of 1 ppm with a standard range of 0-1000 ppm. Temperature and relative humidity variations will have no effect on the unit's accuracy.
  - .3 The sensor will be capable of operating within relative humidity ranges of 5-95% and temperature ranges of 32oF-100oF (0oC-40oC).
  - .4 The Unit will be equipped with a NEMA 4X Polycarbonate-ABS impact-resistant enclosure.
  - .5 The system must provide a menu driven method of checking both zero and span calibrations of the detector; adjustments must be made through the controllers' front panel keyboard. The detectors shall require no periodic maintenance other than yearly zero and span checking with calibrated zero and span gas. Periodic checking or adjustments of the unit shall be capable of being accomplished by one person at the unit location.
  - .6 Stability- the 30 day zero and span drift shall be less than 1% F.S. without the aid of automatic or manual recalibration. The system shall not require any type of auto-zero techniques in order to maintain stability.
  - .7 The sensor alarm levels and unit are to be installed in accordance with the following parameters:

TARGET GASES	FIRST ALARM RECOMMENDED SET POINT	SECOND ALARM RECOMMENDED SET POINT	TRANSMITTER LOCATION	RADIUS OF COVERAGE
<b>S301-IRF-R 134A</b>	250 PPM	500 PPM	300mm (1ft) above the floor	6 Meters (20 feet)

.7 Accessories:

.1 Remote Strobe and Horn – STASR

- .1 Provide CSA/ ULc remote suitable for indoor and/ or outdoor installation audible strobe/horn, as applicable
- .2 The remote mounted unit shall be rated at 85dba at 10 feet (NEMA 4X enclosure for outdoor)
- .3 Provide strobe and horn on each outdoor entrance into the mechanical room and inside the mechanical room to obtain full coverage.

.2 Emergency break glass

- .1 Provide emergency breaking glass switches

.8 Break glass manual switches shall be equivalent to Honeywell Analytics, type EMBG

.16 Air Flow Meters / differential pressure:

- .1 Provide duct mounted, outdoor air louver or hood mounted or fan inlet air flow measuring stations.
- .2 Pressure range and transmitter output to suit application.
- .3 Temperature compensated.
- .4 Capable of withstanding up to 150 percent of rated pressure without damage.
- .5 Each measuring station shall be composed of multiple point measuring probes and a single microprocessor to transmit the output.
- .6 Velocity range shall be between 0 m/s to 25 m/s (0 fpm to 4921 fpm).
- .7 Accuracy shall be 1% of full scale reading.
- .8 Repeatability shall be 0.1% of full scale reading.
- .9 Temperature range shall be between -40°C to 80°C (-40°F to 176°F).
- .10 Meter shall provide an analog 4-20 mA or 0-10 VDC output signal to the BAS controller.
- .11 Acceptable Manufacturers: Veltron DPT, Ebtron Inc., Hybrid Series and Sensocor Inc.
- .12 Space Air Static Differential Pressure: MAMAC Systems Inc. or Setra transmitter.

.17 FLOW ELEMENTS

.1 Manufacturers:

- .1 Fan Inlet: Air Monitor Corporation VOLU-probe/FI, Tek-Air TFP Series or approved equivalent.

- .2 Duct: Air Monitor Corporation VOLU-probe, Sensicon JFMS with A3 display or approved equivalent.
- .2 Provide fan inlet airflow traverse probe mounted in the fan inlets capable of continuously measuring the air handling capacity (air volume) of the respective centrifugal fans.
- .3 The probes shall contain multiple total and static pressure ports along the exterior surface of the cylindrical probes and internally connected to their respective averaging manifolds. Sensors shall not be adversely affected by particle contamination normally present in building system airflows.
- .4 The fan inlet air flow traverse probes shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings and shall be of aluminum construction with hard anodized finish.
- .5 The fan inlet airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level with the system be amplified by its presence in the fan inlet bell.
- .6 For ductwork applications, provide an array of air flow probes arranged to measure the air flow across equal representative areas of the duct cross section, complete with flow straighteners to ensure stable flow measurement.
- .7 The probes shall be capable of producing steady, non-pulsating signals of total and static pressure, without need for flow corrections or factors, with an overall accuracy of  $\pm 3$  percent (1 percent for duct sensors) of actual flow over a fan operating range of 6 to 1 capacity turndown.
- .8 Velocity pressure transmitter shall be selected to suit the system working pressures.
- .9 Check Mechanical Shop Drawing Schedules to determine whether fans are DWDI type requiring a set of offset mounted fan inlet air traverse probes and interconnected signal tubing.
- .10 Install static pressure fittings for duct-mounted differential pressure sensors and switches at a right angle to the flow.
- .18 WATER FLOW METERS (TURBINE)
  - .1 Provide dual turbine insertion meter or venturi style insert meters.
  - .2 Meters to be accurate to 1% of flow reading.
  - .3 Provide flow straighteners where required to ensure proper flow across meter.
  - .4 Meter shall provide an analog 4-20 mA or 0-10 VDC output signal to BAS controller.
  - .5 Continuous operating temperature of 82 Deg C with peak operating temperature of 93 Deg C.
  - .6 Standard of acceptance: Onicon F-1210, Badger or Griswold Metering Station
- .19 WATER FLOW METERS (ELECTROMAGNETIC)
  - .1 Provide electromagnetic insertion or flanged meters.
  - .2 Meters to be accurate to  $\pm 1\%$  of flow reading between 2 ft/s and 20 ft/s.
  - .3 Meter shall provide an analog output for flow rate, a contact closure to indicate flow direction and separate pulse outputs to totalize forward and reverse flows.
  - .4 Liquid temperature range from -9 Deg C to 121 Deg C. Ambient temperature range from -11 Deg C to 65 Deg C.
  - .5 Standard of acceptance: Onicon F-3500 or approved equal

- .20 WATER FLOW METERS (DOMESTIC WATER)
  - .1 Provide Neptune TRU/FLO compound water meters.
  - .2 Measurement element AW WA Class II turbine hydrodynamically balanced rotor.
  - .3 Meters available in 2", 3", 4" and 6".
  - .4 Two magnetic-driven roll-sealed registers
  - .5 Maximum operating pressure is 1034 kPa. Maximum operating temperature is 27 Deg C. (Note: if hot water metering is required, install water meter on the cold side feeding the hot water tank and/ or heat exchanger)
  - .6 Provide Tricon series or E-Coder series pulse and analog transmitters for connection to BAS.
  - .7 Standard of acceptance: Neptune or approved equal
- .21 GAS METER (DIAPHRAGM)
  - .1 Provide diaphragm gas meters as shown on the drawings for fiscal monitoring of gas consumption on specific buildings and equipment.
  - .2 Meter to come complete with die-cast aluminum case, oil-impregnated, self-lubricating bushings, molded convoluted diaphragms, rigid reinforced flag rods, graphite filled phenolic valves to minimize wear, long life low friction grommet seals and high solids polyurethane topcoat.
  - .3 Meter to provide temperature compensation for gas consumption.
  - .4 AMR/AMI compatible.
  - .5 Meter to conform to ANSI B109.1 specifications.
  - .6 Provide meter to suit gas pressure at location.
  - .7 Provide pulse kit for connection to BAS. Meter manufacturer to provide pulse information to BAS contractor.
  - .8 Standard of Acceptance: Canadian Meter (Line Process Control), QMC
- .22 GAS METER (THERMAL MASS FLOW)
  - .1 Provide thermal mass flow gas meters as shown on the drawings for non-fiscal monitoring of gas consumption on specific buildings and equipment.
  - .2 Meters shall be inline style, constructed of 316 stainless steel, and complete with user interface/display.
  - .3 Flow accuracy of meters to be:
    - .1 +/- 1% of reading from 2.54 – 35.56 m/s (500 - 7,000 SFPM).
    - .2 +/- 2% of reading from 0.508 – 2.54 m/s (100 – 500 SFPM).
  - .4 Temperature accuracy of meters to be +/- 0.5°C (1°F) over the range of -40°C to 121°F (40°F to 250°F).
  - .5 Meters shall be suitable for installation across a range of pipe sizes, 19 mm to 150 mm (¾ in. to 6 in.).
  - .6 Maximum pressure drop caused by meter at 12.7 m/s, 21C, and 13.8 kPa (2500 FPM, 70F, and 2 PSIG) shall not exceed:
    - .1 125 Pa (0.5" WC) in pipes 50 mm (2") and larger.
    - .2 225 Pa (0.9" WC) in pipes less than 50 mm (2").

- .7 Meter shall provide an analog 4-20 mA or 0-10 VDC output signal to BAS controller.
- .8 Approvals: FMc (CAN)
  - .1 Class 1, Div 1, Groups B, C, D;
  - .2 Class 2, Div 1, Groups E, F, G;
  - .3 Class 3, Div 1; T4, Ta = -40°C to 70°C;
  - .4 Class 1, Zone 1, AEx/Ex db IIB = H2 T4; Gb Ta = -40°C to 70°C;
  - .5 Type 4X, IP66/67;
- .9 Standard of Acceptance: Onicon F-5500 or approved equal.
- .23 THERMAL (BTU) METER:
  - .1 Provide thermal (BTU) meters as shown on the drawings.
  - .2 Meters shall be suitable for thermal energy measurements in chilled water, hot water, and condenser water system and consist of a flow meter, two temperature sensors, and a user interface/display.
  - .3 Flow meter shall be equal to "Water Flow Meter (Turbine)" specified in this section.
  - .4 Temperature sensors shall be thermistors or resistance temperature detectors (RTDs). Probe material shall be stainless steel, and suitable for installation inside water piping (via thermowell):
    - .1 Temperature Accuracy: +/- 0.1°C (0.15°F)
    - .2 Fluid Temperature Range: -3.9°C (25°F) to 150°C (260°F)
  - .5 Control Panel:
    - .1 Suitable for installation in ambient temperatures of -28.8°C (-20°F) to 60°C (140°F).
    - .2 Enclosure to meet or exceed NEMA 2 rating.
    - .3 Input power shall be either 24 VAC, 60 Hz, 12 VA or 120 VAC, 60 Hz, 15 VA. Contractor to coordinate final power requirement.
    - .4 Meter shall be capable of providing 4 output signals: Energy rate, Flow rate, Supply temperature, and Return temperature
    - .5 Meter shall provide analog 4-20 mA or 0-10 VDC output signals to BAS controller.
  - .6 Approvals: ULc Listed.
  - .7 Standard of Acceptance: Onicon System-10 BTU Meter or approved equal.
- .24 CURRENT SENSORS (CS):
  - .1 Fixed Setpoint, Digital Output Current Switch:
    - .1 Manufacturer: Veris Industries Inc.; Hawkeye 600/800, Greystone Energy, Or approved equivalent
    - .2 Application: Monitoring status of direct drive equipment.
    - .3 Current-operated solid state relay.
    - .4 Split core design.
    - .5 Trip Setpoint: Fixed.
    - .6 Output: Digital switch.



- .7 Sensor Power: Induced from line.
- .2 Adjustable Setpoint, Digital Output, VFD Current Switch:
  - .1 Manufacturer: Veris Industries Inc., Hawkeye 904, Or approved equivalent
  - .2 Application: Monitoring status of belt-drive or direct drive equipment controlled by a VFD.
  - .3 Microprocessor-based current-operated solid state relay.
  - .4 Automatic compensation for VFD frequency and current changes.
  - .5 Split core design.
  - .6 Trip Setpoint: Self-calibrating.
  - .7 Output: Digital switch, with normal and alarm status LED.
  - .8 Sensor Power: Induced from line.
- .25 TIMER/ PUSHBUTTON STATIONS
  - .1 Provide NEMA 12 panel complete with recessed or surface-mounted "on" and "off" stationary or momentary pushbuttons/contacts, to suit the sequence of operation, LED feedback lamp on outer surface of panel.
  - .2 LED shall go on when 'on' pushbutton is pressed, visual indication.
  - .3 If timer is activated the LCD display shall "blink", indicating timer operation.
  - .4 The 'OFF' pushbutton, when pressed, shall override the time remaining and stop the system. LED is "off".
  - .5 Provide non-wear, securely fastened signage next to each pushbutton station.
- .26 DUCT SMOKE DETECTORS
  - .1 Provide CSA certified devices. Photoelectric type, operating on the light scattering principle. Solid state and virtually sealed to prevent being influenced by dirt, dust or humidity. There shall be no moving parts or components that can wear out. Circuitry shall be protected against electrical transients and electromagnetic interference and damage to detector due to polarity reversal or fault on circuit wiring.
  - .2 Detector shall be able to withstand air gusts up to 15 m/sec velocity, have a fine 30-mesh insect screen and be completely sealed at back to prevent entry of dust, moisture and air turbulence. Totally shield electronics of unit to protect against false alarms due to EMI and RFI.
  - .3 Detectors shall be easily disassembled for cleaning, servicing and installation. Installation wiring wired to base only, thus when removing head for maintenance or cleaning no wiring is disturbed. Indicate with LED light to signal operation of unit, facilitating easy viewing from room entry point, glow continuously or rapid flash to indicate alarm condition and able to operate remote lamp or LED. Locking screw on each head will prevent unauthorized removal of head from base.
  - .4 Consisting of spot type addressable smoke detector and air tight housing assembly, mounted on side of duct, accommodating sampling tubes which extend into and across ventilating duct.
  - .5 Provide one air sampling tube length to suit width of duct and air exhaust tube with proper alignment of tubes using mounting plate.
  - .6 While fans are operating, continuous cross sectional sampling of air flows from ventilation duct through detector and return to duct. Air stream range from 18 m/sec maximum velocity to 2.5 m/sec minimum air velocity.

- .7 Provisions to check detector sensitivity under actual air flow conditions, while detector is mounted in its permanent position.
- .8 Incorporate indicating latched or rapid flashing LED to signal operation of unit, facilitating easy viewing from room entry point.
- .9 Provide dual relay outputs for interface with multiple independent systems.
- .27 VARIABLE FREQUENCY DRIVES
  - .1 Variable Frequency Drives: provide variable frequency drives for ALL mechanical equipment indicated on the drawing schedules and/or on the control drawings.
  - .2 For VFD requirements refer to Section 20 08 00
- .28 STARTERS
  - .1 Starters are provided by Division 25.
  - .2 Solid state overload and other HVAC control relays.
  - .3 Accessories (Current sensing device with 4-20 mA output, door mounted H-O-A switch (with auxiliary contacts) and push to test type run and fault LED lights, auxiliary contacts , timers and relays ) to satisfy interlocking and automatic control requirements.
  - .4 Coordinate with Division 26 all interface, wiring diagrams, current sensors, HOA switches etc. required to obtain a complete control system.
- .29 MISCELLANEOUS DEVICES
  - .1 General:
  - .2 RTD to voltage (0 to 5 volt) converters with zero span adjustments for use with analog inputs.
  - .3 Limited range thermistors are acceptable provided they sense expected range for point at specified accuracy with 0 to 5 volt output.
  - .4 Motor starters.
  - .5 Auxiliary contacts in each motor starter.
  - .6 START/STOP relay module for either momentary or maintained switch action as indicated in the Contract Documents.
  - .7 Pilot Relays:
    - .1 Plug in type.
    - .2 Interchangeable.
    - .3 Mounted on a circuit board.
    - .4 Wired to numbered terminal strips.
  - .8 Motorized Step Controllers: Furnish with adjustable (from 17 degrees C to 12 degrees C) deadband between heating and cooling functions.
  - .9 Manual Timer (MT):
    - .1 Manufacturers: M.H. Rhodes-Marktime Inc; Dayton Electrical Manufacturing Co; Broan-Nutone LLC.
    - .2 12 hour, SPST, 120 volt, 20 amp.
    - .3 Spring wound.
    - .4 HOLD feature to override the time clock during off hour operation.

- .5 Install on front cover of HCP.
- .10 Electronic Indication:
  - .1 Furnish temperature-indicating dials or digital read-outs on HCP.
  - .2 65 mm minimum rectangular.
- .11 Strobe/ Horn:
  - .1 Furnish CSA / UL approved strobe & horn assembly, multi-mode visual/ audio signaling device in a single, integrated stack.
  - .2 Colour lens according to Owner requirements.
  - .3 24 VAC, 24 VDC and /or 120 VAC.
  - .4 Edwards Signaling 200 Class 70mm ClearView and/ or 105XBRM Series or equivalent.
- .12 Corrosion resistance
  - .1 All devices installed in corrosive or humid air stream shall be suitable for the application.

## 2.20 WIRING AND RACEWAYS:

- .1 Wiring and raceways shall be provided in accordance with the requirements of Division 26 - Electrical.
- .2 Raceways, metal flex and liquid tight flex as required for the project and shall be provided in accordance with the requirements of Division 26 - Electrical.
- .3 Outlet boxes: shall be provided in accordance with the requirements of Division 26 - Electrical.
- .4 Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment. Tagged "BAS" with a sequential number suffix. Provided in accordance with the requirements of Division 26 - Electrical.
- .5 Provide FT6 plenum rated cable in ceiling plenums and FT4 in conduit for all other cases. Acceptable Manufacturers as follows:
  - .1 Belden
  - .2 Systemeimax
  - .3 Commscope
  - .4 Panduit

## 3 EXECUTION

### 3.1 EXAMINATION

- .1 The Contract Drawings shall be thoroughly examined for control device and equipment locations.
- .2 The Mechanical Contractor shall inspect the site to verify that equipment may be installed as shown on the Contract Drawings and coordinate with other trades to ensure equipment can be installed where shown on the Contract Drawings.
- .3 Any discrepancies, conflicts, or omissions shall be reported to the Consultant for resolution before rough-in work is started.

### 3.2 PROTECTION

- .1 The Controls Contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- .2 The Controls Contractor shall be responsible for his/her work and equipment until final inspection, commissioning, and acceptance. The Controls Contractor shall protect any material that is not immediately installed. The Controls Contractor shall close all open ends of work with temporary covers.

### 3.3 COORDINATION

- .1 Site:
  - .1 Where the mechanical work will be installed near, or will interfere with, work of other trades, the Mechanical Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Controls Contractor installs his/her work before coordinating with other trades, to cause any interference with work of other trades, the Controls Contractor shall make the necessary changes in his/her work to correct the condition with no extra charge to the Owner.
  - .2 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
  - .3 Integrate and coordinate work under this section to controls and control devices provided or installed by others. Mechanical Contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
- .2 Scheduling:
  - .1 Coordinate with the Mechanical, Electrical and General Contractor to ensure submittals are submitted in accordance with the project schedule.
  - .2 Ensure work is coordinated amongst trades and completed in accordance with the project schedule.
  - .3 Provide a list of dependencies (by other trades) that are required for controls to be completed. List shall be provided to ensure that scheduling of other trades will allow ample time for controls to complete their deliverables.
- .3 Testing and Balancing:
  - .1 The Controls Contractor shall furnish a single set of all tools necessary to interface to the control system for testing and balancing purposes.
  - .2 The Controls Contractor shall provide training in the use of these tools. This training shall be planned for a maximum of 4 hours.
  - .3 In addition, the Controls Contractor shall provide a qualified technician to assist in the test and balance process, until the first 5 terminal units are balanced.
  - .4 The tools used during the test and balance process shall be returned at the completion of the testing and balancing.
- .4 Coordination of Controls Specified in Other Sections or Divisions:
  - .1 Other Sections and/or Divisions include controls and control devices that shall be part of or interfaced to the control system specified in this Section. These controls shall be integrated into the system and coordinated by the Controls Contractor as follows:
    - .1 All communication media and equipment shall be provided as specified in Part 2, "Communication" of this Section.
    - .2 Each supplier of a control's product shall be responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in Section 25 95 00 – Sequence of Operations.

- .3 The Mechanical, Electrical or General Contractor shall coordinate and resolve any incompatibility issues that arise between the control's products provided under this Section and those provided under other Sections or Divisions.
- .4 The Equipment Provider shall be responsible for providing a suitable interface to the BAS. Suitable interface could be a BACnet interface or hard wired points but shall be as described in the Contract Documents.

### 3.4 DELIVERABLES

- .1 Provide a fully functioning and complete building automation system as described in the Contract Documents.
- .2 Drawings and Documentation:
  - .1 Provide shop drawings, installation drawings and as built (record) drawings for the project. Provide O&M manuals for the system and all devices.
- .3 Operator Interface:
  - .1 Provide an operator workstation for the project, complete with a fully programmed operator interface software package as described in Part 2. Provide a web based graphical operator interface.
  - .2 Graphics shall be provided as described below:
    - .1 Provide an overall building (facility site) layout and BAS network schematic to initialize the navigation through the various graphics. Overall layout shall include overview information related to scheduling and energy consumption in the building.
    - .2 Provide floor plans for each floor or area. Operator shall be able to switch between various floor plan views as applicable to obtain different information. In all views the floor plans shall provide navigational links to individual control systems. Various floor plans to include: 1) Thermal graphics, 2) Equipment location, 3) Lighting, 4) Energy consumption.
    - .3 Provide individual graphics for each system in the facility. Individual graphics shall include all I/O points for the system, various control carousels as applicable for operator control of the system and dynamic animated graphics (moving fans, dampers, etc.). Graphics shall also contain links to all associated system for quick access to heating/cooling plants, air handling units, VFD's and/or pumping systems. Individual graphics shall also contain energy consumption data where available.
    - .4 Provide 8 hours of field work dedicated to developing custom dashboards (graphics) with the building Owner/Operator. Time shall allow for custom dashboard generation to enable the Owner/Manager/Operator access to intuitive dashboards to key information they require.
- .4 Facility Scheduling:
  - .1 Provide 4 hours of field work dedicated to setting up time schedules and optimal start/stop programs with the Owner.
- .5 Alarm Monitoring and Annunciation:
  - .1 Set up alarms as described in Section 25 95 00 – Sequence of Operations for each system.
  - .2 Provide 4 hours of field work dedicated to setting up alarms with the Owner. Set up shall implement the Owner's method for monitoring, annunciating and handling alarms.

- .6 Trends and Record Keeping:
  - .1 Set up trends as described in Section 25 95 00 – Sequence of Operations for each system.
  - .2 Provide 4 hours of field work dedicated to setting up trends with the Owner. Set up shall include establishing and storing trend information for systems as required by the Owner.
- .7 Demand Limiting and Energy Consumption:
  - .1 Set up interaction for energy optimization between systems as described in Section 25 95 00 – Sequence of Operations.
  - .2 Provide 4 hours of field work dedicated to ensuring all demand limiting and energy conservation strategies are set up according to the Owner's energy plan.
- .8 All work with the Owner as described above shall be provided after training to ensure the Owner is familiar with concepts and has a plan in place that can be executed by the Controls Contractor.
- .9 Provide all controllers and devices as required to deliver a fully functioning BAS as described in this Section and Section 25 95 00 – Sequence of Operations.
- .10 Provide all wiring and installation of supplied devices (except those devices installed by other trades).
- .11 Provide all programming, verification and start up required.
- .12 Provide all training as described in this Section.
- .13 Provide warranty services as described in this Section.

### 3.5 GENERAL WORKMANSHIP

- .1 Install all controllers, cabinets, control devices and power supplies in readily accessible locations providing adequate ambient conditions for its specified application and to the Canadian Electrical Code.
- .2 Install products to manufacturer's installation instructions.
- .3 Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.
- .4 Mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

### 3.6 FIELD QUALITY CONTROL

- .1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, provincial, and federal codes and ordinances as identified in Part 1, "References" of this Section.
- .2 Controls Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- .3 Controls Contractor shall have work inspected by local and/or provincial authorities having jurisdiction over the work as required.

### 3.7 WIRING AND CONDUIT

- .1 Provide and install all control and interlock wiring in compliance with national and local electrical codes, as well as Division 26.
- .2 Where the requirements of this Section differ from those in Division 26, the requirements of Division 26 shall take precedence.

- .3 All Class 1 (line voltage) wiring shall be installed in rigid galvanized steel conduit (TRGSC) or Electric Metallic Tube (EMT) conduit with metal flex, as per Division 26.
- .4 All wiring in mechanical, electrical, telephone, parking garage, between floors and/or where subject to mechanical damage shall be rigid galvanized steel conduit (TRGSC) or Electric Metallic Tube (EMT) conduit with metal flex, as per Division 26 with metal flex.
- .5 All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be fused when required to meet Class 2 current limit.)
- .6 Where Class 2 wires are in concealed and accessible locations, including ceiling return air plenums, approved FT6 cables not in raceway may be used.
- .7 Class 2 wiring in raceway containing Class 1 wiring shall not be installed. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two (for example, relays and transformers).
- .8 Wiring in raceway containing tubing shall not be installed.
- .9 Exposed wiring will not be accepted. Conduit shall run parallel or perpendicular to the building walls.
- .10 Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- .11 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- .12 All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- .13 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- .14 Size of raceway and size and type of wire shall be the responsibility of the Controls Contractor, in keeping with the Manufacturer's recommendations and electrical code requirements, except as noted elsewhere in the Contract Documents.
- .15 Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- .16 Use coded conductors throughout with conductors of different colors.
- .17 Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on flexible duct strap or tie rods. Raceways shall not run on or be attached to ductwork.
- .18 Adhere to Division 26 requirements where raceway crosses building expansion joints.
- .19 Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- .20 The Controls Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- .21 Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Liquid tight flex shall be used where exposed to moisture.
- .22 Raceway shall be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations shall be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.
- .23 Install control and interlock wiring separate from power wiring.

- .24 Number code or colour code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.
- .25 Provide wire markers on each conductor in the panel and at load connections. Identify circuit with control wire number.
- .26 Restrain wiring in control panels by plastic ties or ducts.
- .27 Hinge wiring shall be secured at each end so that any bending or twisting will be around longitudinal axis of wire and bend area shall be protected with sleeve.
- .28 Arrange wiring neatly, cut to length, and remove surplus wiring. Provide abrasion protection for any wire bundles that pass through holes or across edges of sheet metal.
- .29 Use the manufacturer's recommended tool with proper sized anvil for crimp terminations. No more than two wires may be terminated in single crimp lug and no more than two lugs may be installed on single screw terminal

### 3.8 IDENTIFICATION OF HARDWARE

- .1 All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.
- .2 Permanently label or code each point of field terminal strips to show the instrument or item served.
- .3 Identify control panels with minimum 1 cm (0.5") letters on laminated plastic nameplates.
- .4 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- .5 Identify room sensors relating to terminal box or valves with nameplates.
- .6 Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

### 3.9 CONTROLLERS

- .1 Provide a separate controller for each AHU, Chiller, Boiler, or other HVAC system. A DDC controller may control more than one system provided that the second system is a minor system (EF, RHC, etc.) and all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement. Where equipment is provided/ needed for redundancy, controllers are to maintain the level of redundancy of the equipment they serve. Controllers should be considered as a single point of failure, and one controller should not serve both the base, and redundant equipment.
- .2 Field Controllers shall be selected to provide capacity for future equipment (1 addition boiler and 1 additional chiller) as well as a minimum of 20% spare I/O point capacity for each point type found at each location. If input points are not universal, 20% of each type is required. If outputs are not universal, 20% of each type is required. A minimum of one spare is required for each type of point used. VAV and Terminal Unit controllers are excluded from the spare points requirements.
- .3 Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points.
- .4 Building Controllers shall allow an additional 20% capacity without the need for additional building controllers.

### 3.10 INSTALLATION OF SENSORS

- .1 Install sensors in accordance with the Manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for the environment within which the sensor operates.



- .3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Room temperature sensors shall be mounted at 1,220 mm (48") above finished floor (confirm with the Consultant prior to installation).
- .4 All room temperatures sensors installed against an exterior surface shall be provided with insulated backing.
- .5 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- .6 Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- .7 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m<sup>2</sup> (1 ft of sensing element for each 1 ft<sup>2</sup>) of coil area.
- .8 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- .9 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- .10 Differential Air Static Pressure:
  - .1 Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
  - .2 Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
  - .3 Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
  - .4 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
  - .5 All pressure transducers shall be mounted in a location accessible for service.
  - .6 All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

### 3.11 PROGRAMMING

- .1 Provide enough internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.
- .2 Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- .3 Software Programming:
  - .1 Provide programming for the system and adhere to the sequences of operation provided in Section 25 95 00 – Sequence of Operations. All other system programming necessary for the operation of the system, but not specified in this Section, shall be provided by the Controls Contractor. Imbed into the control program enough comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

- .1 Text-based:
  - .1 Must provide actions for all possible situations;
  - .2 Must be modular and structured; and,
  - .3 Must be commented.
- .2 Graphic-based:
  - .1 Must provide actions for all possible situations; and,
  - .2 Must be documented.
  - .3 Operator Interface:
- .4 Standard graphics: Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
  - .1 On top of individual graphics, show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
  - .2 The Controls Contractor shall provide all the labour necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this Section and Section 25 95 00 – Sequence of Operations. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

### 3.12 CONTROL SYSTEM CHECKOUT AND TESTING

- .1 Start-up Testing: All testing listed in this Section shall be performed by the Controls Contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's Representative is notified of the system demonstration.
  - .1 The Controls Contractor shall furnish all labour and test apparatus required to calibrate and prepare to service all instruments, controls, and accessory equipment furnished under this Section.
  - .2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
  - .3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to the Manufacturers' recommendations.
  - .4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
  - .5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start, and span are correct, and that direction and normal positions are correct. The Controls Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Controls Contractor shall make any necessary adjustments to valve stem and damper blade travel.
  - .6 Verify that all hardwired safety devices (freezestats, high pressure, etc.) are functional and protect the equipment when it is operating in both the 'hand' and 'auto' modes.

- .7 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines.
- .8 Alarms and Interlocks:
  - .1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
  - .2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
  - .3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

### 3.13 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- .1 Demonstration:
  - .1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this Section. These tests shall occur after the Controls Contractor has completed the installation, started up the system, and performed his/her own tests.
  - .2 The tests described in this Section shall be performed in addition to the tests that the Controls Contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this Section. The Engineer shall be present to observe and review these tests. The Consultant shall be notified at least 10 days in advance of the start of the testing procedures.
  - .3 The approved checklists and forms shall be completed for all systems as part of the demonstration.
  - .4 The Controls Contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Controls Contractor.
  - .5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
  - .6 Demonstrate compliance with Part 1, Part 2, Part 3 of the specification.
  - .7 Demonstrate compliance with sequences of operation through all modes of operation.
  - .8 Demonstrate operation of operator interface.
  - .9 Additionally, the following items shall be demonstrated:
    - .1 DDC loop response: The Controls Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Controls Contractor.

- .2 Demand limiting: The Controls Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over a minimum 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of trendable equipment outputs.
- .3 Optimum start/stop: The Controls Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
- .4 Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Consultant. These logs shall cover three 48-hour periods and have a sample frequency of maximum 10 minutes. The logs shall be provided in electronic form (PDF format).
- .10 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Controls Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests, with no extra cost to the Owner.
- .2 Acceptance:
  - .1 All tests described in this Section shall have been performed to the satisfaction of both the Consultant, third party commissioning agent, and the Owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Controls Contractor may be exempt from the completion requirements if stated as such in writing by the Consultant. Such tests shall then be performed as part of the warranty.
  - .2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved by the Consultant and in accordance with Part 1, "Submittals".

### 3.14 CLEANING

- .1 The Controls Contractor shall clean up all debris resulting from his/her activities on a daily basis. The Controls Contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location on site.
- .2 At the completion of work in any area, the Controls Contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, debris, etc.
- .3 At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas with no extra cost to the Owner.

### 3.15 TRAINING

- .1 Provide a minimum of eight on-site or classroom training sessions, half a day each, throughout the contract period for personnel designated by the Owner (32 hours total).
- .2 Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be half a day in length and must be coordinated with the Owner.
- .3 Train the designated staff of the Owner's and the Owner to prepare them for the following:
  - .1 Day-to-day Operators:

- .1 Proficiently operate the system;
- .2 Understand control system architecture and configuration;
- .3 Understand DDC system components;
- .4 Understand system operation, including DDC system control and optimizing routines (algorithms);
- .5 Operate the workstation and peripherals;
- .6 Log on and off the system;
- .7 Access graphics, point reports, and logs;
- .8 Adjust and change system set points, time schedules, and holiday schedules;
- .9 Recognize malfunctions of the systems;
- .10 Understand system drawings and O&M manual;
- .11 Understand the job layout and location of control components;
- .12 Access data from DDC controllers and Air System Controllers (ASCs); and,
- .13 Operate portable operator's terminals.
- .2 Advanced Operators:
  - .1 Make and change graphics on the workstation;
  - .2 Create, delete, and modify alarms, including annunciation and routing of these;
  - .3 Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals;
  - .4 Create, delete, and modify reports;
  - .5 Add, remove, and modify system's physical points;
  - .6 Create, modify, and delete programming;
  - .7 Add panels when required;
  - .8 Add operator interface stations;
  - .9 Create, delete, and modify system displays, both graphical and others;
  - .10 Perform DDC system field checkout procedures;
  - .11 Perform DDC controller unit operation and maintenance procedures;
  - .12 Perform workstation and peripheral operation and maintenance procedures;
  - .13 Perform DDC system diagnostic procedures;
  - .14 Configure hardware including PC boards, switches, communication, and I/O points;
  - .15 Maintain, calibrate, troubleshoot, diagnose, and repair hardware; and,
  - .16 Adjust, calibrate, and replace system components.
- .3 System Managers/Administrators:
  - .1 Maintain software and prepare backups;
  - .2 Interface with job-specific, third-party operator software; and,
  - .3 Add new users and understand password security procedures.

- .4 Provide course outline and materials in accordance with Part 1, "Submittals". The instructor(s) shall provide one copy of training material per student.
- .5 The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- .6 Classroom training shall be done using a network of working controllers, representative of the installed hardware.

**END OF SECTION 25 00 00**

1 GENERAL

1.1 CONTROL SYSTEM - GENERAL NOTES

- .1 Unless otherwise noted, all controls shall be direct digital type (DDC). Actuators shall be electric, unless otherwise noted.
- .2 The terms "building automation system" (BAS), "building management system" (BMS), and "building control system (BCS) may be used interchangeably throughout the control diagrams and sequences of operation.
- .3 As a minimum, one DDC field control panel (DDCFP) shall be provided for each air handling unit or major piece of equipment or system.
- .4 All setpoints indicated in the sequences shall be adjustable at the host computer workstation, via a laptop computer connected to any BCS control panel or controller, and via HTML 5 browser connected to the cloud/enterprise sever.
- .5 The building control system (all control panels, workstations, host computer, etc.) Shall be connected to standby power (UPS or otherwise).
- .6 Software communication shall be required between the BCS and equipment manufacturer's packaged control systems. Provide all integration/gateways necessary between the equipment and BCS.
- .7 Refer to floor plans for the locations of all space mounted sensors and transmitters. Where not shown, space mounted sensors and transmitters shall be provided and coordinated by the Control's Contractor (mark up locations on plans and present to client/consultant for review).
- .8 All common information (outside air temperature, ambient CO<sub>2</sub> level, etc.) Shall be measured and communicated over the BCS network.
- .9 An outdoor weather station shall be provided to record ambient air temperature, humidity, and ambient CO<sub>2</sub>.
- .10 Space CO<sub>2</sub> sensors shall incorporate an ABC (automatic background calibration) algorithm. The algorithm shall only not be applied for 24 hour occupied spaces.
- .11 The sequences shall be performed by the DCFP and monitored by the BCS.
- .12 Each sequence with a defined occupied period shall have the period adjustable globally (so that all can be the same time frame) and individually (so that any one operation can have a different occupied period).
- .13 Factory provided controls shall be used on all equipment whenever available as an equipment OEM option, for integration via a single communication cable.
- .14 The controls contractor and mechanical contractor shall coordinate factory provided OEM equipment, sensors, and instruments prior to bid.
- .15 BAS system interconnection shall be provided through the IT system, Controls Contractor will be responsible to coordinate with the owner's IT staff, and the communications contractor as required.

1.2 SEQUENCES OF OPERATION - GENERAL NOTES

- .1 Sequences of operations outlined (unless otherwise specified) shall be performed by direct digital control field panels (DDCFP) connected to central building automation system. Address identifiers for all points and variables shown in the diagrams shall be coordinated with the control system and owner. Unless otherwise specified, all setpoints and time delays shall be adjustable by the operator through the BAS and through menu access at the local terminal / unitary controller without any hardware or software revisions. Monitoring of all

- functions shall be available at the BMS and at the DDCFP. Provide menu driven capability for the operator to override automated start/stop sequences for each piece of equipment (pumps, air handling units, etc.). If a sequence is disabled by the operator but an automatic start is initiated, the system shall issue an alarm stating that the equipment was unable to start/stop due to user input. The BAS shall then attempt to start the next sequential piece of equipment.
- .2 The design intent is for the control system to monitor pressures, temperatures, flow to control valves, and variable frequency drives (VFD). Monitored data will be used to energize or deenergize the equipment.
  - .3 All equipment controlled by the DDC system shall be capable of manual operation through hand-off-automatic (HOA) switches in starters and VFD provided. The positions of all valves controlled by the building control system shall be capable of manual positioning (open, closed, modulated, auto).
  - .4 The entire facility shall have an emergency shutdown sequence shall that is capable of being initiated at the operations center. The emergency shutdown sequence shall confirm the input status for all equipment (providing ventilation) and confirm shutdown of all required fan systems (except those serving emergency systems).
  - .5 Coordinate all sensor installations with the mechanical contractor and submit proposed locations on piping coordination drawing submittal. Coordinate to ensure that the sensor manufacturer's recommended upstream and downstream diameters are provided (especially flow elements and transmitters).
  - .6 Provide communications interface and software between the BCS and each equipment manufacturer supplied control panel to read/display all data available at the panel via manufacturer's protocol. Where control is required provide input/output interface indicated.
  - .7 Fail-safe positions (spring return, battery or capacitor bank...etc.) indicated are positions that devices will go to when deenergized.
  - .8 Provide adequate damping of all modulating control loops to prevent hunting.
  - .9 Provide a single global scheduling (occupancy) override of all equipment to place the entire building into the occupied mode to allow for special events.
  - .10 Whenever a unit is shut down because of one of its safeties, the BCS shall retain in memory the readings and setpoints of each device to help the operator isolate the cause of the shutdown.
  - .11 Whenever an alarm is initiated, the BCS shall retain in memory the readings and setpoints of each device to assist the operator to isolate the cause of the alarm.
  - .12 If any local, terminal, unitary controller or equipment manufacturer's control system loses communication with the BCS network, an alarm shall be generated by the BCS indicating the location of the fault.
  - .13 Each mechanical system inclusive of all equipment and components operating as a single system (e.g HRU, FCUs, etc.) shall have a single operator BAS virtual push button for:
    - .1 Enable / disable
    - .2 Purge mode (modulate ventilation air up to 100% of design flow)

### 1.3 STATUS - "SYSTEMOK" GENERAL NOTES

- .1 Each system shall have a "Systemok" flag to report "True" or "False" to the building control system.
- .2 "Systemok" = True
  - .1 The system is proven "On"



- .2 The system is achieving its temperature and/or pressure setpoint(s) for at least 5 minutes.
- .3 The system is ready and able to serve its load.
- .3 "Systemok" = False
  - .1 System is in the sequence / process of startup.
  - .2 Enough of the system's components are unavailable (in alarm, disabled, or turned off) to disrupt the ability of the system to serve its load.
  - .3 Alarms
    - .1 Level 1, 2, and some level 3 alarms (as determined by the client) shall inhibit a "Systemok" status.
    - .2 Level 4 alarms shall not affect "Systemok".

#### 1.4 VARIABLE FREQUENCY DRIVE - GENERAL NOTES

- .1 The hand-off-automatic switch on the VFD shall provide for the following basis of control:
  - .1 Hand position: the DDC system shall have no control over the motor speed, nor shall it be able to start or stop the motor (except for safety purposes where the motor shall shut down). The motor shall run under speed control from the hand potentiometer on the VFD. All safeties controlling the shutdown shall be operational (i.e., smoke detectors, pressure switches, etc.) Temperature and humidity control shall be available through the building control system.
  - .2 The VFD hardwiring and control logic will enable an open-air path (e.g. open isolation dampers, mixing dampers, etc.) prior to enable motor start in Auto or Hand position.
  - .3 Warning: Due to limited or no BMS control in Hand mode, all system parameters are to be monitored by operator and adjusted accordingly from the Operator Interface.
  - .4 Off position: the motor shall be off. The buildings control system shall not control the motor. All other control points shall be in their fail-safe position.
  - .5 Automatic position: the motor shall be controlled by the direct digital control system as described within the sequences of operation.

#### 1.5 ALARMS - GENERAL NOTES

- .1 There shall be four (4) levels (or classes) of alarm. Levels are described below:
  - .1 Level 1 alarms: life-safety message
  - .2 Level 2 alarms: critical / high priority message
  - .3 Level 3 alarms: moderate priority message
  - .4 Level 4 alarms: low priority message
- .2 Alarms shall include the minimum following information:
  - .1 Time & date of alarm
  - .2 Level of alarm
  - .3 Description of alarm
  - .4 Equipment tags for the units in alarm
  - .5 Possible causes of the alarm if provided by the fault detection routines
  - .6 The source that serves the equipment in alarm
- .3 Alarm configuration includes (each alarm):

- .1 Level of alarm
- .2 Latching requirements
- .3 Entry delay
- .4 Exit hysteresis
- .5 Postexit suppression period
- .6 Alarm specific messages
- .4 Operators shall have the ability to place equipment in/out of maintenance mode allowing the suppression of alarms.
  - .1 Level 1 alarms shall not be suppressed
- .5 Entry delays (default entry delays shown below may be modified to better serve the requirement for each specific alarm):
  - .1 Level 1 alarms: 1 second
  - .2 Level 2 alarms: 10 seconds
  - .3 Level 3 alarms: 1 minute
  - .4 Level 4 alarms: 5 minutes
- .6 Exit hysteresis (default exit hysteresis shown below shall be modified to better serve the requirement(s) for each specific alarm):
  - .1 Time: 5 seconds
  - .2 % of limit: 0%
- .7 Latching (default settings may be modified to better serve the requirement for each specific alarm):
  - .1 Level 1 alarms: latching
  - .2 Level 2 alarms: latching
  - .3 Level 3 alarms: non-latching
  - .4 Level 4 alarms: non-latching
- .8 Post exit suppression period (default periods shown below may be modified to better serve the requirement(s) for each specific alarm):
  - .1 Level 1 alarms: 0 minutes
  - .2 Level 2 alarms: 5 minutes
  - .3 Level 3 alarms: 24 hours
  - .4 Level 4 alarms: 7 days
- .9 The controls contractor shall tune alarm requirements specifically for each application as required for optimal operations for each process, and device.

#### 1.6 STATIC PRESSURE RESET - GENERAL NOTES

- .1 Trim and respond:
  - .1 Trim and respond (T&R) static pressure reset logic shall reset (reduce) the differential static pressure setpoint at fixed rate and set intervals until downstream zone(s) are no longer satisfied and generates enough request(s) for an increased setpoint. Once increased and the downstream zone(s) are no longer sending enough "Requests", the setpoint shall resume the trim operation until the sequence is repeated.

- .2 Trim and respond valves to be programmed within the reset logic shall include but are not limited to: (defaults shown are for fan systems, modify defaults as required for both implementation of fan systems and hydronic systems):
  - .1 SPo - Initial setpoint (Default = 0.5)
  - .2 SPmin - Minimum setpoint (Default = 0.15)
  - .3 SPmax - Maximum setpoint (Default = System design setpoint)
  - .4 Td - Delay timer (Default = 5 minutes)
  - .5 T - Time step (Default = 2 minutes)
  - .6 I - Number of ignored requests (Default = 2 requests)
  - .7 R - Number of requests from zones / systems
  - .8 SPtrim - Trim amount (Default = -0.04")
  - .9 SPres - Respond amount (Must be opposite in sign to SPtrim) (Default = +0.06")
  - .10 SPres-max - Maximum response per time interval (Must be same as SPres) (Default = +0.15")
- .3 Each downstream zone shall have the following characteristics:
  - .1 Importance multiplier (Default = 1)
    - .1 Used to scale the number of requests.
    - .2 System shall be tuned to identify "Rogue Zones" that prevent proper T&R operation.
  - .2 Request-hours
    - .1 Every x minutes (Default = 5 minutes), add x/60 times the current number of requests to this request hours accumulator point. The request-hours accumulator point is reset to zero upon a global command from the system/plant serving the zone/system - this global point simultaneously resets the request-hours point for all zones/system served by this system / plant.
  - .3 Cumulative%-request-hours
    - .1 Zone/system request hours divided by the zone/system run hours, expressed as a percentage. Unoccupied hours shall not be recorded.
- .4 Logic
  - .1 The static pressure shall be reset between the minimum (SPmin) and the design static pressure (SPmax).
  - .2 When the fan / pump is off, the setpoint shall be froze to the initial static pressure setpoint allowed (SPo).
  - .3 When the system is enabled, the T&R logic shall include a delay (td) to allow for initial equipment startup.
  - .4 When active, the static pressure shall be reduced by the setpoint trim valve (SPtrim) every time step (t).
  - .5 If there are more than the number of setpoint ignore (i) request; respond by changing the setpoint by the number of requests minus the number of ignore

requests [SPres x (r-i)]. The static pressure setpoint shall not be increased beyond the maximum allowable setpoint (SPmax).

.5 Alarms

.1 If the zone importance factor is greater than zero, the zone/system cumulative%-request-hours exceeds 70%, and the total number of zone/systems run-hours exceeds 40; generate a level 4 alarm at the bas & graphic user interface.

.6 Tuning: each zone and system utilizing T&R logic shall be tuned specifically for that application. The values suggested are a starting point and will likely require adjustment during the commissioning/tuning phase.

.2 Critical zone:

.1 Critical zone static pressure reset logic shall reset the differential static pressure setpoint based on the critical damper or valve position. This critical damper / valve position shall be the input into the PID control loop. Using the PID control logic, the most critical damper / valve shall be adjusted by resetting the differential static pressure to maintain a setpoint of 90% open.

.2 When the fan / pump is off, the PID loop shall be disabled to prevent wind-up and freeze the output at zero.

.3 The static pressure shall be reset between the range of 0.15 inches (0% PID output) and the design static pressure (100% PID output).

1.7 ZONE GROUPS

.1 Each system shall be broken into separate zone groups composed of a collection of one or more zones served by a single air handling unit.

.2 Each zone group shall be capable of having separate occupancy schedules and operating modes from other zone groups.

.3 All zones in each zone group shall be in the same zone-group operating mode. If one zone is placed in any zone-group operating mode other than unoccupied (due to override, sequence logic, or scheduled occupancy), all zones in that zone group shall enter that mode.

.4 A zone group may be in only one mode at a given time.

.5 Provide a set of testing / commissioning software switches that override all zones served by the zone group.

.6 Each terminal unit within the zone group shall have separate dedicated overrides.

1.8 ZONE GROUP OPERATING MODES

.1 Occupied mode:

.1 The mode occurs when the following is true:

.1 The time of day is between the zone group's scheduled occupied start and stop times.

.2 The schedules have been overridden by the occupant override system.

.3 Any zone local override time (initiated by local override button) is nonzero.

.2 Unoccupied mode:

.1 Off:

.1 The mode occurs when the zone group is not in any other mode.

.2 Warm-up mode:

- .1 For each zone the bas shall calculate the required warm-up time to reach the occupied heating setpoint at the scheduled occupancy time. An "optimal start" algorithm shall use the following to calculate the time for each zone warm-up:
  - .1 The current zone temperature
  - .2 The occupied heating setpoint
  - .3 The outdoor air temperature
  - .4 The zone's mass/capacity factor
- .2 The mass/capacity factor shall be manually adjusted for each zone or self-adjusting by the BMS.
  - .1 If the mass/capacity factor is self-adjusting thru the bas, the self-tuning process shall be turned off (stopped) once the system has self-tuned and has been trained.
- .3 Warm-up mode shall start based on the zone with the longest calculated warm-up time requirement, but no earlier than 3 hours prior to the scheduled occupancy period.
- .4 Warm-up mode shall end at the scheduled occupied start time.
- .5 Zones where the window switch indicates that the window is open shall be ignored.
- .3 Cooldown mode:
  - .1 For each zone the bas shall calculate the required cool-down time to reach the occupied cooling setpoint at the scheduled occupancy time. An "optimal start" algorithm shall use the following to calculate the time for each zone cool-down:
    - .1 The current zone temperature
    - .2 The occupied cooling setpoint
    - .3 The outdoor air temperature
    - .4 The zone's mass/capacity factor
  - .2 The mass/capacity factor shall be manually adjusted for each zone or self-adjusting by the bas.
    - .1 If the mass/capacity factor is self-adjusting thru the bas, the self-tuning process shall be turned off (stopped) once the system has self-tuned and has been trained.
  - .3 Cool-down mode shall start based on the zone with the longest calculated cool-down time requirement, but no earlier than 3 hours prior to the scheduled occupancy period.
  - .4 Cool-down mode shall end at the scheduled occupied start time.
  - .5 Zones where the window switch indicates that the window is open shall be ignored.
- .4 Setback mode:
  - .1 During the unoccupied mode, if any 5 zones (or all zones if there are fewer than 5) in the zone group fall below their unoccupied heating setpoints, or if the average zone temperature of the zone group falls below the average

unoccupied heating setpoint; the zone group shall enter setback mode until all spaces in the zone group are 2°F above their unoccupied setpoints.

.5 Freeze protection mode:

.1 During the unoccupied mode, if any single zone falls below 40°F; the zone group shall enter setback mode until all zones are above 45°F, and a level 3 alarm shall be set.

.6 Setup mode:

.1 During the unoccupied mode, if any 5 zones (or all zones if there are fewer than 5) in the zone group rise above their unoccupied cooling setpoints, or if the average zone temperature of the zone group rises above the average unoccupied cooling setpoint; the zone group shall enter setup mode until all spaces in the zone group are 2°F below their unoccupied setpoints.

.2 Zones where the window switch indicates that the window is open shall be ignored.

1.9 AVERAGE VALUE

.1 Where multiple sensors are provided for same area or function (e.g. temperature sensors) the average value of all sensors shall be used. If either sensor fails, the remaining operational sensors will assume control and average function, and a Level 3 alarm will be generated.

1.10 HRU-1: DEDICATED OUTDOOR AIR SYSTEM (DOAS) SERVING FAN COIL UNITS (FCU)

.1 General:

.1 Unit shall operate as a variable volume air handling unit.

.2 The unit provides 100% outdoor air to fan coil units while maintaining the supply air temperature and humidity at set point. Set points are adjusted for both energy efficiency and comfort. Fan speed is adjusted based on the mode all FCUs are in (Occupied, Daytime Setback, Unoccupied) and to maintain proper building pressurization.

.3 Controls described herein shall be performed by DDC controller using electric actuation and either PI or PID control logic. PI or PID control shall be determined by the applications ability for control tuning. Provide all interface, wiring, relays, interlocks, controls, and programming as required for operation.

.4 Unit shall generally consist, but not limited to, the following:

.1 Supply fan(s) and Exhaust fan(s) with VFD speed control(s).

.2 Chilled glycol coil(s).

.3 Heating glycol coil(s).

.4 Filter sections.

.5 Motorized isolation dampers.

.6 Air flow stations.

.7 Humidifier section.

.8 Variable speed energy recovery wheel.

.5 The air handling unit shall have, as a minimum, the following hardwired connections:

.1 BACNET IP network interface for monitoring unit operation and performance.

.2 Supply air & return air smoke detection.

.3 Fire alarm and/or fire protection and/or suppression system.

- .4 Safety related items, e.g. high/low temp, pressure, humidity switches, etc.
- .2 **Building management system (BMS) interface:**
  - .1 The DDC field control panel shall communicate virtual points to the BMS.
  - .2 ALL virtual points shall be mapped to the BMS and shall be readable and/or writeable through the BACNET communications link.
  - .3 If communication is lost with the BMS, the unit controller shall operate using its last communicated setpoints and run command and an alarm shall be generated.
- .3 **Scheduling**
  - .1 HRU shall be able to operate continuously (24 hours per day) and or by Operator selectable Schedule.
  - .2 The unit shall be programmed to be capable of operating in two occupancy modes and various sub-operating modes that shall be made available 24/7 for operation. Refer to the "Zone Groups" and "Zone Groups Operating Modes" descriptions section for operating modes to be made available to the unit.
- .4 **Safeties and Limits:**
  - .1 The outdoor air and exhaust air dampers shall be hardwired to their respective supply and exhaust fan VFDs. Damper must prove open (end switch) for the fan to run. Damper interlock will also work if the fan is run in 'hand' mode.
  - .2 A low temperature limit is hardwired to shut down the unit (supply fan), close the outdoor air damper and fully open the heating valve when the sensed temperature drops below 4°C (39°F). Once tripped, the limit switch must be reset manually. A 5-minute time delay is provided on start-up to bypass the limit and allow time for the heating system to come under control. Protection will work when the fan is in either 'hand' or 'auto' mode.
  - .3 A high static pressure limit is hardwired to shut down the supply fan when the sensed pressure is above set point. Manual reset is required. Protection will work when the fan is in either 'Hand' or 'Auto' mode.
  - .4 Fan speed modulation is disabled until fan run status is received.
  - .5 Supply air temperature control is disabled until fan run status is received.
  - .6 If the supply air temperature rises above 55°C (131°F), the controller will shut down the unit and issue an alarm. Manual reset through the BAS is required.
  - .7 If the return air temperature rises above 55°C (131°F), the controller will shut down the unit and issue an alarm. Manual reset through the BAS is required.
  - .8 Simultaneous heating and cooling are not permitted.
  - .9 When the cooling plant is seasonally disabled the cooling valve will go to its relaxed (fully closed) state.
  - .10 When the heating plant is seasonally disabled the heating valve will go to its relaxed (fully open) state.
  - .11 The humidifier is disabled when the outdoor air temperature is above 10°C (50°F).
  - .12 The fire alarm system is hardwired to the fan VFD by Div 26 and will shut down the unit in the event of a fire alarm and/or activation of duct smoke detector.
- .5 **Start-up/Shut down:**
  - .1 When the unit is off, the supply fan, heat wheel and the exhaust fan shall be off, and the outside and exhaust air dampers are fully closed.

- .2 Upon a call for start-up the exhaust fan shall start first at minimum speed. Once the exhaust fan run status is received, the supply fan shall start at minimum speed. Once run status is received on both fans the controller will allow both fans to modulate above minimum speed.
- .3 At start up the initial static pressure set point will be set to 350 Pa (1.4" w.c.).
- .4 At start up the initial supply air temperature set point will be set to 13°C (55°F).
- .6 **Modes of Operation:**
  - .1 Three modes of operation are available, occupied mode, daytime setback, and unoccupied mode.
  - .2 **Occupied Mode:**
    - .1 Overview: The unit will provide conditioned ventilation air to the associated zoned FCUs / RTU and constant sanitary exhaust (from washroom, janitor rooms, etc.).
    - .2 Supply Fan + Outside Air Damper:
      - .1 The supply fan runs continuously while the outside air damper end switch is proven open.
      - .2 The supply fan speed is controlled by a VFD and shall operate at 100%, as well as maintain building pressure.
    - .3 Exhaust Fan + Exhaust Air Damper:
      - .1 The exhaust fan runs continuously while the exhaust air damper end switch is proven open.
      - .2 The exhaust fan shall be controlled by a VFD and shall be tracked digitally in relation to the supply fan. The airflow offset will be initially set to -10% to ensure a positive pressure inside the building. A wall mounted; accessible pressure sensor will monitor and maintain a pressure differential of 15 Pa (0.06" w.c.) of the building in relation to the outdoor air pressure.
    - .4 Supply Air Temperature Setpoint Reset:
      - .1 A temperature controller, with its sensing element located in the supply air, shall modulate in sequence the heat wheel, and heating coil or cooling coil valve to maintain base set point 13°C (55°F).
      - .2 The actual supply air temperature set point is equal to the base supply air temperature set point +/- an offset determined by the heating and cooling requests from the space.
      - .3 The maximum actual supply air temperature set point is 22°C (72°F) and the minimum actual supply air temperature set point is 13°C (55°F). The supply air temperature set point will be initially set as per the Start-up procedure and adjusted by the BAS as follows. The set point will be increased by 1°C (2°F) from the base set point every 60 minutes if the chilled water control valves of all associated FCUs are fully closed. The set point will be immediately decreased by 1°C (2°F) if the chilled water control valve of any associated FCU opens, as well as an additional 1°C (2°F) every 5 minutes that the chilled water control valve is opened.
    - .5 Heat Recovery Wheel:
      - .1 The heat recovery wheel shall recover energy from the exhaust air stream and introduce energy into the supply air stream.



- .2 The speed of heat recovery wheel shall be modulated to maintain the supply air temperature set point.
- .3 The VFD shall automatically slow the speed of the heat recovery wheel to reduce the sensible and latent effectiveness of the wheel when necessary to prevent frost formation. The frost prevention speed shall be determined via a formula/sequence approved by the heat recovery wheel manufacturer. The formula shall be a function of the humidity level in the exhaust air stream, outdoor air temperature, and/or differential pressure across the wheel.
- .6 Cooling Coil Valve:
  - .1 The valve will be modulated to maintain the supply air temperature at set point.
  - .2 When the exhaust air is warmer than outdoor air and there is a call for cooling the heat recovery wheel shall be disabled, bypass dampers shall open, and the cooling coil shall be the only form of cooling.
  - .3 The cooling coil will be the second form of cooling while the heat recovery wheel is active. The cooling coil will be activated when the leaving supply air temperature of the heat wheel rises above 15°C (59°F) for longer than 30 minutes.
- .7 Heating Coil Valve:
  - .1 The valve will be modulated to maintain the supply air temperature at set point.
  - .2 The heating coil will be activated when the leaving supply air temperature of the heat wheel drops below 11°C (52°F) for longer than 30 minutes.
- .3 **Daytime Setback Mode:**
  - .1 Overview: If all FCUs and the RTU are in Daytime Setback Mode the HRU shall throttle back.
  - .2 Supply Fan + Outside Air Damper:
    - .1 The supply fan runs continuously while the outside air damper end switch is proven open.
    - .2 The supply fan speed is controlled by a VFD and shall operate at 50%, as well as maintain building pressure.
  - .3 Exhaust Fan + Exhaust Air Damper:
    - .1 The exhaust fan runs continuously while the exhaust air damper end switch is proven open.
    - .2 The exhaust fan shall be controlled by a VFD and shall be tracked digitally in relation to the supply fan. The airflow offset will be initially set to -10% to ensure a positive pressure inside the building. A wall mounted; accessible pressure sensor will monitor and maintain a pressure differential of 15 Pa (0.06" w.c.) of the building in relation to the outdoor air pressure.
  - .4 Heat Recovery Wheel:
    - .1 The heat recovery wheel shall recover energy from the exhaust air stream and introduce energy into the supply air stream.

- .2 The speed of heat recovery wheel shall be modulated to maintain the supply air temperature set point.
- .3 The VFD shall automatically slow the speed of the heat recovery wheel to reduce the sensible and latent effectiveness of the wheel when necessary to prevent frost formation. The frost prevention speed shall be determined via a formula/sequence approved by the heat recovery wheel manufacturer. The formula shall be a function of the humidity level in the exhaust air stream, outdoor air temperature, and/or differential pressure across the wheel.
- .5 **Cooling Coil Valve:**
  - .1 The valve will be modulated to maintain the supply air temperature at set point.
  - .2 When the exhaust air is warmer than outdoor air and there is a call for cooling the heat recovery wheel shall be disabled, bypass dampers shall open, and the cooling coil shall be the only form of cooling.
  - .3 The cooling coil will be the second form of cooling while the heat recovery wheel is active. The cooling coil will be activated when the leaving supply air temperature of the heat wheel rises above 15°C (59°F) for longer than 30 minutes.
- .6 **Heating Coil Valve:**
  - .1 The valve will be modulated to maintain the supply air temperature at set point.
  - .2 The heating coil will be activated when the leaving supply air temperature of the heat wheel drops below 11°C (52°F) for longer than 30 minutes.
- .4 **Unoccupied Mode:**
  - .1 **Overview:** The unit is off.
  - .2 **Supply Fan + Outside Air Dampers:** The damper is closed, and the supply fan is off.
  - .3 **Exhaust Fan + Exhaust Air Dampers:** The damper is closed, and the exhaust fan is off.
  - .4 **Heat Recovery Wheel:** The heat recovery wheel is off.
  - .5 **Cooling Coil Valve:** The valve is closed.
  - .6 **Heating Coil Valve:** The valve is modulated to maintain the heat wheel leaving supply air temperature at 10°C (50°F) (unless opened by seasonal disable).
- .7 **Integration with Other Systems:**
  - .1 The unit will receive the seasonal status of the heating and cooling plants to allow the valves to relax (spring relief).
  - .2 The unit will provide 'run requests' to the heating and cooling plants when they are required.
  - .3 The unit will provide a 'heating request' to the heating plant to raise the supply water temperature when the heating valve is fully open, and the supply air temperature is more than 1°C (2°F) below set point. Request is released when the valve drops below 80% open.

- .4 The unit will provide a 'cooling request' to the cooling plant to lower the supply water temperature when the cooling valve is fully open, and the supply air temperature is more than 1°C (2°F) above set point. Request is released when the valve drops below 80% open.
- .5 In the event the heat recovery wheel stops functioning the unit shall notify the heating plant to allow the standby boiler to function to meet heating demands.
- .6 Fresh air and supply air temperature set point requests are received from FCU/RTU controllers (fan coil unit heating and chilled water valves).
- .8 **Alarms:**
  - .1 Airflow alarm
    - .1 An airflow stations are provided on supply and exhaust air.
    - .2 Level 2 Alarm: Upon a signal to the air fan to be enabled, if the airflow is not proven within 15 seconds (provide delay for damper opening and startup procedures);
      - .1 Deenergize the fan(s).
      - .2 Dampers shall return to their fail-safe positions.
      - .3 The chilled water and heating water valves shall return to their fail-safe positions.
      - .4 Alarm shall be provided.
    - .3 Level 3 alarm: upon a signal to the fan to be disabled, if no airflow after 2 minutes, generate a level 3 alarm
    - .4 Disable/ inhibit humidifier operation (prevent water/ condensation)
  - .2 Damper position alarms
    - .1 All dampers shall be provided with position indication.
    - .2 Level 2 alarm: upon a signal to open the isolation damper, if the position switch does not activate within the installed damper actuator motor drive run time + 10 seconds; generate an alarm.
  - .3 Filter status alarm:
    - .1 A differential pressure sensor shall monitor the differential pressure across the filters(s).
    - .2 The maximum filter differential pressure setpoint shall be verified and coordinated with the capabilities of the filter style and filter manufacturer.
    - .3 Level 4 alarm: If the filter differential pressure is greater allowable differential pressure; generate an alarm at the bas & graphic user interface.
    - .4 Level 3 alarm: if the filter differential pressure is greater than 110% of the calculated allowable differential pressure; generate a level 3 alarm at the bas & graphic user interface.
  - .4 Freezestat alarm
    - .1 Level 2 alarm: A freezestat shall be mounted downstream of the hot water heating coil
    - .2 The freezestat shall use an averaging low temperature detection sensor / switch and be reset manually (reset shall be located at accessible location).
    - .3 Alarm: upon activation of the freezestat (setpoint shall be 38°F);

- .1 Deenergize the fan(s).
  - .2 Dampers shall return to their fail-safe positions.
  - .3 The chilled water and heating water valves shall return to their fail-safe positions.
  - .4 Alarm shall be provided.
- .5 High static pressure alarm
  - .1 A static pressure switches shall be provided.
  - .2 The high discharge static pressure switch alarm shall be manually reset (reset shall be located at accessible location).
  - .3 Level 2 alarm: upon activation of the high-pressure switch;
    - .1 Deenergize the fan(s).
    - .2 Dampers shall return to their fail-safe positions.
    - .3 The chilled water and heating water valves shall return to their fail-safe positions.
    - .4 Alarm shall be provided.
- .6 Fire Alarm:
  - .1 Fire alarm indication shall be provided.
  - .2 Level 1 alarm: upon activation of the fire alarm signal;
    - .1 Deenergize the fan(s).
    - .2 Dampers shall return to their fail-safe positions.
    - .3 The chilled water and heating water valves shall return to their fail-safe positions.
    - .4 A signal shall also be sent to the fire alarm control panel.
    - .5 Alarm shall be provided.
- .7 Low duct static pressure alarm
  - .1 Software logic shall monitor the duct static pressure within the supply ductwork.
  - .2 Level 3 alarm: at the duct static pressure sensor, if the static pressure drops - 0.3" below the setpoint for a duration of more than 5 minutes; an alarm shall be generated.
- .8 Supply air temperature alarm
  - .1 Software logic shall monitor the discharge supply temperature from the unit.
  - .2 Level 3 alarm: at the supply air temperature sensor, if the discharge air temperature rises/drops above or below the setpoint temperature by 5 degrees or more for a duration of 15 minutes or more, an alarm shall be generated
- .9 Supply air humidity alarm
  - .1 Software logic shall monitor the discharge supply humidity / dewpoint from the unit.

- .2 Level 3 alarm: at the supply air humidity sensor, if the discharge air humidity rises above 66°F dew point for a duration of 15 minutes or more, an alarm shall be generated.
- .10 Variable frequency drive fault alarm
  - .1 Faults generated by an associated variable frequency drive; the unit shall de-energize associated fan(s).
  - .2 Level 2 alarm: upon report of a fault
    - .1 Deenergize the associated fan(s).
    - .2 For multiple supply, multiple return/exhaust fan unit only: The unit shall remain in operation with the remaining fan(s) that are operable.
    - .3 Alarm shall be provided.
- .11 CO<sub>2</sub> sensor alarms
  - .1 If the CO<sub>2</sub> concentration exceeds setpoint plus 10% for more than 10 minutes, generate a level 3 alarm at the BAS & graphic user interface.
  - .2 If the CO<sub>2</sub> concentration is less than 300 ppm, or the zone is in unoccupied mode for more than 2 hours and the zone CO<sub>2</sub> concentration exceeds 600 ppm, generate a level 3 alarm at the BAS & graphic user interface. The alarm text shall identify the sensor and indicate that it may be out of calibration.
- .9 **Loss of Power:**
  - .1 Upon loss of power; all dampers, valves, etc. Shall return to their fail-safe positions.
  - .2 The air handling unit controller shall retain all information regarding the setpoints and status of operation at the time of power failure.
  - .3 Upon restoration of power, the air handling unit shall have a delay of 60 seconds prior to restart.
    - .1 All air handling units shall provide a staggered start operation to minimize electrical demand surge during restart.
  - .4 The unit shall be programmed to allow for an automatic restart upon a power failure and restoration of power.
  - .5 The unit shall return to the status and operation being performed prior to the power failure.
- .10 **Testing/commissioning overrides**
  - .1 Provide software switches that interlock to a chilled water and hot-water plant system level point to perform the following:
    - .1 Force heating water valve full open.
    - .2 Force heating water valve full closed.
    - .3 Force chilled water valve full open.
    - .4 Force chilled water valve full closed.
    - .5 Plant chilled water supply request.
    - .6 Plant heating water supply request.

.11 **Trends:**

- .1 All inputs and outputs will be trended at 30-minute intervals for and stored for 3 days, at the end of each day the oldest day's data will be automatically deleted.
- .2 Certain trends shall not automatically delete and shall be saved indefinitely until the user decided to delete the data, those trends shall be as follows:
  - .1 Supply air temperature set point and reading.
  - .2 Supply air static pressure set point and reading.
  - .3 Supply air volume set point and reading from airflow measuring station.
  - .4 Exhaust air volume set point and reading from airflow measuring station.
  - .5 Exhaust air humidity set point and reading.

1.11 **TYPICAL FAN COIL UNIT (FCU)**

.1 **General:**

- .1 The FCU system provides ventilation air, as well cooling and heating to the space. Supplemental heating (where applicable, eg. baseboards, cabinet unit heaters, etc.) will provide secondary sources of heat for the space.
- .2 The unit shall generally consist of the following:
  - .1 Supply fan c/w electronically commutated (EC) motor.
  - .2 Chilled glycol control valve.
  - .3 Heating glycol control valve.
  - .4 Air filter.
  - .5 All required sensors and transmitters.
  - .6 Thermostat / controller.
- .3 Local adjust on space sensor to be limited to +/- 2°C (+/- 4°F).
- .4 Fan coil units for rooms equipped with occupancy sensors (office areas, meeting rooms, etc.) shall be used to switch between occupied, daytime setback, and unoccupied mode.
- .5 Fan coil units for rooms not equipped with occupancy sensors (mechanical rooms, electrical rooms, data closets, etc.) shall be operated by BAS schedule (initially set to 24/7 operations).
- .6 The fan coil unit shall have a BACNET IP controller.

.2 **Building management system (BMS) interface:**

- .1 The BAS shall monitor temperatures and setpoints from the fan coil unit controller.
- .2 If communication is lost with the BMS, the unit controller shall operate using its last communicated setpoints and run command and an alarm shall be generated.

.3 **Modes of Operation:**

- .1 Three modes of operation are available for the fan coil units: occupied, daytime setback mode, and unoccupied mode. All of which are determined by a time-of-day schedule, local occupancy sensors, and local CO<sub>2</sub> sensors.
  - .1 Occupied mode is engaged when the local occupancy sensors detect a presence in the room, when the time-of-day schedule notes that the room should be in the occupied mode, or when the local CO<sub>2</sub> sensors detect levels higher than 600 ppm.

- .2 Daytime setback mode is engaged when the local occupancy sensor does not detect a presence in the room and the time-of-day schedule notes the room should be in the daytime setback mode.
- .3 Unoccupied mode is engaged when the local occupancy sensor does not detect a presence in the room and the time-of-day schedule notes the room should be in the nighttime unoccupied mode.

.2 **Occupied Mode:**

- .1 Overview: The FCU will provide variable airflow to the space to maintain the space temperature at set point. The space temperature set point will be set to 23°C (73°F). An acceptable deviation of +/- 1°C (+/- 2°F) will be applied to the space temperature set point to allow for heating and cooling control. Cold air from the fan coil unit provides cooling to the space. Warm air from the fan coil unit provides heating to the space.
- .2 Ventilation Air: The FCU shall call for fresh air to be provided by the HRU at 100% capacity.
- .3 Airflow Set point:
  - .1 The airflow set point is automatically calculated between the minimum flow (approx. 30% design flow) and maximum flow (design flow) to maintain the space thermostat at set point.
  - .2 During heating mode, the fan coil unit shall maintain airflow at minimum set point until the heating coil valve is fully open or until the discharge temperature reaches 30°C (86°F) at which point fan speed will begin to modulate up to design airflow.
  - .3 During cooling mode, the fan coil unit shall maintain airflow at minimum set point until the cooling coil valve is fully open or until the discharge temperature reaches 13°C (55°F) at which point fan speed will begin to modulate up to design airflow.
- .4 Cooling Coil Valve: The valve will be modulated to maintain the space thermostat at set point.
- .5 Heating Coil Valve: The valve will be modulated to maintain the space thermostat at set point.

.3 **Daytime Setback Mode:**

- .1 Overview: The FCU will provide variable airflow to the space to maintain the space temperature at the nighttime unoccupied set points. The space temperature heating set point will be set to 21°C (70°F) and the space temperature cooling set point will be set to 25°C (77°F).
- .2 Ventilation Air: The FCU shall call for fresh air to be provided by the HRU at 50% capacity.
- .3 Airflow Set point:
  - .1 The airflow set point is automatically calculated between the minimum flow (per manufacturer) and maximum flow (design flow) to maintain the space thermostat at set point.
  - .2 During heating mode, the fan coil unit shall maintain airflow at minimum set point until the heating coil valve is fully open or until the discharge temperature reaches 30°C (86°F) at which point fan speed will begin to modulate up to design airflow.

- .3 During cooling mode, the fan coil unit shall maintain airflow at minimum set point until the cooling coil valve is fully open or until the discharge temperature reaches 13°C (55°F) at which point fan speed will begin to modulate up to design airflow.
- .4 Cooling Coil Valve:
  - .1 On a rise in space temperature above set point, modulate the cooling glycol control valve towards the open position.
  - .2 On a fall in space temperature, modulate the cooling glycol control valve towards the closed position.
- .5 Heating Coil Valve:
  - .1 On a fall in space temperature below set point, modulate the heating glycol control valve towards the open position.
  - .2 On a rise in space temperature, modulate the heating glycol control valve towards the closed position.
- .4 **Unoccupied Mode:**
  - .1 Overview: The FCU will be cycled to maintain the space temperature at the unoccupied set points. The space temperature heating set point will be set to 18°C (64°F) and the space temperature cooling set point will be set to 28°C (82°F).
  - .2 Ventilation Air: Fresh air shall not be provided by the HRU.
  - .3 Airflow Set point:
    - .1 The airflow set point shall be cycled on and off at maximum flow (design flow) to maintain the space thermostat at set point.
    - .2 During heating mode once discharge temperature reaches 30°C (85°F) air flow shall be increased to maintain the maximum discharge temperature.
    - .3 During cooling mode once discharge temperature reaches 13°C (55°F) air flow shall be increased to maintain the maximum discharge temperature.
  - .4 Cooling Coil Valve:
    - .1 On a rise in space temperature above set point, modulate the cooling glycol control valve towards the open position.
    - .2 On a fall in space temperature, modulate the cooling glycol control valve towards the closed position.
  - .5 Heating Coil Valve:
    - .1 On a fall in space temperature below set point, modulate the heating glycol control valve towards the open position.
    - .2 On a rise in space temperature, modulate the heating glycol control valve towards the closed position.
- .4 **Integration with Other Systems:**
  - .1 A ventilation request will be sent to the HRU depending on if the FCU is in occupied, daytime setback, or unoccupied mode.
  - .2 A heating request will be sent to the heating plant when the heating coil valve is fully open.



- .3 A cooling request will be sent to the cooling plant when the cooling coil valve is fully open.
- .5 **Alarms:**
  - .1 Unit fan failure alarm:
    - .1 Level 2 alarm: on failure to run, disable the unit's fan and send an alarm to the building control system. Generate a level 2 alarm at the BAS & graphic user interface.
  - .2 Space/zone temperature alarm:
    - .1 Low-temperature alarm
      - .1 Level 3 alarm: if the space/zone is 10°F below heating lower limit setpoint for 10 minutes, generate a level 3 alarm at the BAS & graphic user interface.
      - .2 Level 2 alarm: if the space/zone is 20°F below heating lower limit setpoint for 10 minutes, generate a level 2 alarm at the BAS & graphic user interface.
      - .3 Low-temperature alarms shall be suppressed in the following conditions:
        - .1 heating system status of 'Systemok' is reported as 'False'
        - .2 BMS disconnection alarm
    - .2 High-temperature alarm
      - .1 Level 3 alarm: if the space/zone is 10°F above cooling lower limit setpoint for 10 minutes, generate a level 3 alarm at the BAS & graphic user interface.
      - .2 Level 2 alarm: if the space/zone is 20°F above cooling lower limit setpoint for 10 minutes, generate a level 2 alarm at the BAS & graphic user interface.
      - .3 High-temperature alarms shall be suppressed in the following conditions:
        - .1 cooling system status of 'Systemok' is reported as 'False'
        - .1 BMS disconnection alarm
- .6 **Loss of power:**
  - .1 The unit shall be programmed to allow for an automatic restart upon a power failure and restoration of power.
  - .2 The unit shall return to the status and operation being performed prior to the power failure.
- .7 **Trends:**
  - .1 All inputs and outputs will be trended at 30-minute intervals for and stored for 3 days, at the end of each day the oldest day's data will be automatically deleted.
  - .2 Certain trends shall not automatically delete and shall be saved indefinitely until the user decided to delete the data, those trends shall be as follows:
    - .1 Space temperature set point and temperature.

## 1.12 ROOFTOP UNIT (RTU-1) SERVING CALL/ DISPATCH (103) & SUPERVISOR (106)

### .1 General:

- .1 The RTU system provides cooling and heating to the space, it shall function as the primary heating and cooling source for these spaces.
- .2 The unit shall generally consist of the following:
  - .1 Supply fan(s) and Return fan(s) with VFD speed control(s).
  - .2 Chilled glycol control valve.
  - .3 Heating glycol control valve.
  - .4 Air filter.
  - .5 All required sensors and transmitters.
  - .6 Thermostat / controller.
- .3 Local adjust on space sensor to be limited to +/- 2°C (+/- 4°F).
- .4 The rooftop unit shall have a BACNET IP controller.

### .2 Building management system (BMS) interface:

- .1 The BAS shall monitor temperatures and setpoints from the rooftop unit controller.
- .2 If communication is lost with the BMS, the unit controller shall operate using its last communicated setpoints and run command and an alarm shall be generated.

### .3 Scheduling

- .1 RTU shall be able to operate continuously (24 hours per day) and or by Operator selectable Schedule.

### .4 Modes of Operation:

- .1 Three modes of operation are available for the roof top unit: occupied, daytime setback mode, and unoccupied mode. All of which are determined by a time-of-day schedule, local occupancy sensors, and local CO<sub>2</sub> sensors.
  - .1 Occupied mode is engaged when the local occupancy sensors detect a presence in the room, when the time-of-day schedule notes that the room should be in the occupied mode, or when the local CO<sub>2</sub> sensors detect levels higher than 600 ppm.
  - .2 Daytime setback mode is engaged when the local occupancy sensor does not detect a presence in the room and the time-of-day schedule notes the room should be in the daytime setback mode.
  - .3 Unoccupied mode is engaged when the local occupancy sensor does not detect a presence in the room and the time-of-day schedule notes the room should be in the nighttime unoccupied mode.
- .2 **Occupied Mode:**
  - .1 Overview: The RTU will provide variable airflow to the space to maintain the space temperature at set point. The space temperature set point will be set to 23°C (73°F). An acceptable deviation of +/- 1°C (+/- 2°F) will be applied to the space temperature set point to allow for heating and cooling control. Cold air from the RTU provides cooling to the space. Warm air from the RTU provides heating to the space.
  - .2 Ventilation Air: The RTU shall call for fresh air to be provided by the HRU at 100% capacity.

.3 Airflow Set point:

- .1 The airflow set point is automatically calculated between the minimum flow (approx. 30% design flow) and maximum flow (design flow) to maintain the space thermostat at set point.
- .2 During heating mode, the fan coil unit shall maintain airflow at minimum set point until the heating coil valve is fully open or until the discharge temperature reaches 30°C (86°F) at which point fan speed will begin to modulate up to design airflow.
- .3 During cooling mode, the fan coil unit shall maintain airflow at minimum set point until the cooling coil valve is fully open or until the discharge temperature reaches 13°C (55°F) at which point fan speed will begin to modulate up to design airflow.

.4 Cooling Coil Valve: The valve will be modulated to maintain the space thermostat at set point.

.5 Heating Coil Valve: The valve will be modulated to maintain the space thermostat at set point.

.3 **Daytime Setback Mode:**

.1 Overview: The RTU will provide variable airflow to the space to maintain the space temperature at the nighttime unoccupied set points. The space temperature heating set point will be set to 21°C (70°F) and the space temperature cooling set point will be set to 25°C (77°F).

.2 Ventilation Air: The RTU shall call for fresh air to be provided by the HRU at 50% capacity.

.3 Airflow Set point:

- .1 The airflow set point is automatically calculated between the minimum flow (per manufacturer) and maximum flow (design flow) to maintain the space thermostat at set point.
- .2 During heating mode, the fan coil unit shall maintain airflow at minimum set point until the heating coil valve is fully open or until the discharge temperature reaches 30°C (86°F) at which point fan speed will begin to modulate up to design airflow.
- .3 During cooling mode, the fan coil unit shall maintain airflow at minimum set point until the cooling coil valve is fully open or until the discharge temperature reaches 13°C (55°F) at which point fan speed will begin to modulate up to design airflow.

.4 Cooling Coil Valve:

- .1 On a rise in space temperature above set point, modulate the cooling glycol control valve towards the open position.
- .2 On a fall in space temperature, modulate the cooling glycol control valve towards the closed position.

.5 Heating Coil Valve:

- .1 On a fall in space temperature below set point, modulate the heating glycol control valve towards the open position.
- .2 On a rise in space temperature, modulate the heating glycol control valve towards the closed position.

.4 **Unoccupied Mode:**

- .1 Overview: The RTU will be cycled to maintain the space temperature at the unoccupied set points. The space temperature heating set point will be set to 18°C (64°F) and the space temperature cooling set point will be set to 28°C (82°F).
- .2 Ventilation Air: Fresh air shall not be provided by the HRU.
- .3 Airflow Set point:
  - .1 The airflow set point shall be cycled on and off at maximum flow (design flow) to maintain the space thermostat at set point.
  - .2 During heating mode once discharge temperature reaches 30°C (85°F) air flow shall be increased to maintain the maximum discharge temperature.
  - .3 During cooling mode once discharge temperature reaches 13°C (55°F) air flow shall be increased to maintain the maximum discharge temperature.
- .4 Cooling Coil Valve:
  - .1 On a rise in space temperature above set point, modulate the cooling glycol control valve towards the open position.
  - .2 On a fall in space temperature, modulate the cooling glycol control valve towards the closed position.
- .5 Heating Coil Valve:
  - .1 On a fall in space temperature below set point, modulate the heating glycol control valve towards the open position.
  - .2 On a rise in space temperature, modulate the heating glycol control valve towards the closed position.

.5 **Integration with Other Systems:**

- .1 A ventilation request will be sent to the HRU depending on if the RTU is in occupied, daytime setback, or unoccupied mode.
- .2 A heating request will be sent to the heating plant when the heating coil valve is fully open.
- .3 A cooling request will be sent to the cooling plant when the cooling coil valve is fully open.

.6 **Alarms:**

- .1 Unit fan failure alarm:
  - .1 Level 2 alarm: on failure to run, disable the unit's fan and send an alarm to the building control system. Generate a level 2 alarm at the BAS & graphic user interface.
- .2 Space/zone temperature alarm:
  - .1 Low-temperature alarm
    - .1 Level 3 alarm: if the space/zone is 10°F below heating lower limit setpoint for 10 minutes, generate a level 3 alarm at the BAS & graphic user interface.

- .2 Level 2 alarm: if the space/zone is 20°F below heating lower limit setpoint for 10 minutes, generate a level 2 alarm at the BAS & graphic user interface.
    - .3 Low-temperature alarms shall be suppressed in the following conditions:
      - .1 heating system status of 'Systemok' is reported as 'False'
      - .2 BMS disconnection alarm
    - .2 High-temperature alarm
      - .1 Level 3 alarm: if the space/zone is 10°F above cooling lower limit setpoint for 10 minutes, generate a level 3 alarm at the BAS & graphic user interface.
      - .2 Level 2 alarm: if the space/zone is 20°F above cooling lower limit setpoint for 10 minutes, generate a level 2 alarm at the BAS & graphic user interface.
      - .3 High-temperature alarms shall be suppressed in the following conditions:
        - .1 cooling system status of 'Systemok' is reported as 'False'
        - .1 BMS disconnection alarm
  - .7 **Loss of power:**
    - .1 The unit shall be programmed to allow for an automatic restart upon a power failure and restoration of power.
    - .2 The unit shall return to the status and operation being performed prior to the power failure.
  - .8 **Trends:**
    - .1 All inputs and outputs will be trended at 30-minute intervals for and stored for 3 days, at the end of each day the oldest day's data will be automatically deleted.
    - .2 Certain trends shall not automatically delete and shall be saved indefinitely until the user decided to delete the data, those trends shall be as follows:
      - .1 Space temperature set point and temperature.

1.13 **HEATING GLYCOL PLANT**

  - .1 **General:**
    - .1 The heating system is composed of the following equipment to generate and distribute heating water/glycol for the facility:
      - .1 Two (2) condensing gas-fired boilers (duty/standby).
      - .2 Three (3) heat recovery chiller (duty/duty/standby).
      - .3 Two (2) variable primary loop heating glycol pumps (duty/standby).
    - .2 The heat recovery chiller is the primary method of generating heating glycol for the facility. The heat recovery chiller will be supplemented with heating glycol generated by condensing boilers.
    - .3 The system provides heating glycol to fan coil units, cabinet heaters, air handling unit coils and heat recovery unit coils.
    - .4 The heating glycol distribution loop is variable flow (the boilers and heat recovery chillers shall be capable of variable flow).

- .5 Flow meters and temperature sensor shall be provided throughout to allow the BAS the able to monitor and control system flow.
- .6 The BAS will interface with the boilers/heat recovery chiller via BACnet gateway. Additional points will be provided on the BAS so that all OEM points can be controlled and monitored.
- .2 **Control components include (but are not limited to) the following:**
  - .1 Control valves / actuators / transmitters to modulate flow through boilers, system bypasses, drains, etc.
  - .2 flow meters to record system flows and system load / energy use.
  - .3 differential pressure sensors / transmitters to modulate flow through variable speed pumps.
  - .4 Communications and all available control points shall be taken from the boiler control panels through a network software connection.
- .3 **Boiler/Heat Recovery Chiller - Building Management System (BMS) interface:**
  - .4 The building management system will monitor the status of all boilers and heat recovery chillers to determine the equipment's availability to operate and serve the load of the facility.
  - .5 Review the boiler and heat recovery operating status conditions to differentiate between status reports that indicate that a boiler/heat recovery chiller is operating or return to operation and status conditions that indicate the boiler will not come back online without manual corrective action due to a latching alarm.
  - .6 When a latching alarm occurs; the boiler/heat recovery chiller shall be disabled and alarmed.
  - .7 When a boiler/heat recovery chiller is not enabled or is in a latching alarm condition, the boiler water valves shall be closed.
  - .8 The building control system shall obtain ALL control points from the boiler's control panel (BACnet) and/or from a boiler interface panel.
  - .9 If additional boiler control points are required in addition to the boiler panel interface, they shall be provided by the control's contractor through a separate interface panel or hard-wired connections.
  - .10 All points available from the boiler, through an interface panel, or directly from the boiler controller, whether listed above or not, shall be brought into a detailed, graphical chiller control and status screen.
  - .11 Boiler load shall be received from the boiler control panel and/or calculated from control devices.
  - .12 Provide a maintenance toggle switch at each boiler which will make the boiler unavailable to the control system. This will allow the boiler to start manually without effecting operation of controls.
- .13 **Safeties and Limits:**
  - .1 The heating boilers are equipped with factory mounted hardwired safety limits.
  - .2 Boilers are disabled until their primary pump run status is proven on. If boilers are running and a primary pump failure occurs (commanded on and status is not received – 10 second delay), the boiler will be immediately disabled. Boiler will be automatically re-enabled once the primary pump status has been on for more than 1 minute.

- .3 If a primary pump or boiler fails, the next available boiler/primary pump will be enabled.
- .4 If a lead secondary pump fails (commanded on and status not received – 1 minute delay), an alarm will be issued, and the standby pump started. Command to the failed pump will remain on. Pump failure will be cleared by the controller (alarm still archived on the BAS) once pump run status has been on for more than 1 minute.
- .5 Minimum run time for a boiler is 5 minutes.
- .6 If the remote differential pressure sensor is not reading (or network is down) the system will default to a local differential pressure set point of 175 kPa (25.4 psi).
- .7 Minimum pump speed for a variable speed pump is 18 Hz.
- .14 **Alternation of Equipment:**
  - .1 Pump pairs will be alternated between duty and standby on a weekly basis to maintain equal runtimes.
  - .2 Boilers will be alternated between duty and standby on a weekly basis to maintain equal runtimes.
- .15 **Modes of Operation:**
  - .1 The heating plant should be seasonally enabled/disabled by the Operator. When seasonally enabled, the system will operate as described. When seasonally disabled, the system will stay in the disabled mode. The Operator should verify system operation each season prior to enabling.
  - .2 When the outdoor air temperature is above 15°C (59°F) for more than 2 hours, the heating system is disabled.
  - .3 When the outdoor air temperature is between 5°C and 15°C (41°F and 59°F), the system will be put into the heating mode when a run request is received. The system will be disabled when no run requests have been received for more than 15 minutes. Run requests are generated when a heating valve is open (1%). Run requests are disabled once the valve has been closed for 5 minutes.
  - .4 When the outdoor air temperature is below 5°C (41°F), the system will operate in the heating mode regardless of run requests.
  - .5 The system is put into the Safe Mode when the outdoor air temperature sensor fails.
- .16 **Start-up/Shut down:**
  - .1 When boilers are started, the DDC controller will rate limit the boiler to slowly heat the boiler material and water.
  - .2 When boilers are stopped, their primary pump will be held “ON” for an additional 5 minutes to dissipate heat from the boiler.
- .17 **Enabled Mode:**
  - .1 Overview: The heating plant is controlled to maintain the supply temperature at setpoint. The setpoint is automatically adjusted via the control system to provide the lowest supply temperature that will satisfy the building load. Distribution pump speed is controlled to maintain the differential pressure at set point. The differential pressure set point is automatically adjusted via the control system to provide the least amount of pumping energy while ensuring water is available for all equipment in the facility.
  - .2 Heating Glycol Supply Temperature Setpoint Reset: The base set point will be reset from as follows:

Outdoor Air Temperature	Supply Temperature
-------------------------	--------------------

-10°C (14°F)	54°C (130°F)
+ 5°C (41°F)	43°C (110°F)

The actual set point will be equal to the base set point +/- an offset. The offset will range between +/- 15°C (+/- 27°F). When a heating request is received the offset will increase 1°C (2°F) every 10 minutes. When no heating requests are received the offset will decrease 1°C (2°F) every 20 minutes. Heating requests are generated when a heating valve is 90% open. The request is reset once the valve is less than 80% open. Regardless of the offset calculation, the minimum set point is 35°C (95°F) and the maximum set point is 68°C (155°F).

- .3 Differential Pressure Setpoint Reset: The local differential pressure set point will be automatically reset between 100 kPa and 300 kPa (14.5 psi to 43.5 psi) to maintain the remote DP sensor at 40 kPa (5.8 psi).
- .4 Distribution Pumps: The duty pump runs continuously. Pump speed is controlled to maintain the local differential pressure at set point.
- .5 Bypass Valve: When the pump is operating at minimum speed the bypass valve will modulate to maintain the differential pressure at set point. When the pump is above minimum speed the valve will be closed.
- .6 Heat Recovery Chiller: The heat recovery chiller will operate as the primary heat source when a simultaneous demand for cooling is present. The heat recovery chiller shall continue to operate to maintain cooling setpoint and reject heat into the heating glycol loop to satisfy the heating demand. When the heating demand is not longer detected the heat recovery chiller shall automatically switch over and reject heat to the air-cooled condenser. Controls contractor to confirm/coordinate exact staging parameters with the procured heat recovery chiller manufacturer.
- .7 Boilers + Isolating Vales: The boiler will be enabled when the heat recovery chiller has been operating above 95% capacity for longer than 10 minutes (adjustable) or shall be available immediately if discharge water temperature has dropped 2°C (4°F) below setpoint. No boiler shall be energized until it's associated isolation valve has been proven open. The standby boiler will be enabled when the duty boiler is disabled, or a heat recovery wheel inside one of the HRU/RTU has been disabled. When enabled, all boilers will modulate to maintain the leaving water temperature at set point. Controls contractor to confirm/coordinate exact staging parameters with the boiler manufacturer. Minimum boiler run time shall be 15 minutes to prevent short cycling.

.18 **Disabled Mode:**

- .1 Overview: The system is off.
- .2 Distribution Pumps: The distribution pumps are off.
- .3 Bypass Valve: The valve is open.
- .4 Boiler Primary Pumps: The pumps are off.
- .5 Boilers: The boilers and their primary pumps are off.

.19 **Safe Mode:**

- .1 Overview: The safe mode is used when the outdoor air temperature sensor fails to ensure heat is still available for the building, in the event the sensor fails in winter. An alarm will be issued indicating the plant is running in the 'Safe Mode'. The system will operate as per the normal heating mode with the following exceptions:
  - .1 Outside Air Temperature: The controller will assume the outside air temperature is -20°C (-4°F).

.20



.21 **Heat Wheel Failure Mode:**

- .1 Overview: The heat wheel failure mode is used when the heat recovery wheel in an HRU fails to operate. The HRU in alarm will send a signal to indicate that the heat recovery wheel is no longer functioning. This will allow the standby boiler to operate so that discharge supply air temperature can be maintained, and continuous ventilation is provided throughout the facility.

.22 **Integration with other Systems:**

- .1 The outside air temperature is shared over the BAS network.
- .2 Run requests are received via the network from dependent systems. They are sent to the heating plant when a heating valve is open 1% or more. The run request is reset once the valve has been closed for more than 5 minutes.
- .3 Heating requests are received via the network from dependent systems. They are sent to the heating plant when the heating valve is open more than 90%. The heating request is reset once the valve is less than 80% open.
- .4 The controller will share the seasonal status of the heating plant to allow all heating control valves to relax (spring relief).
- .5 Heat wheel failed indicators are received from the HRU when a heat recovery wheel is discovered to be in a critical alarm.

.23 **Critical Alarms:**

- .1 Pump failure.
- .2 System operating in Safe Mode.
- .3 Low HGS pressure.
- .4 The system is seasonally disabled, and the outdoor air temperature drops below 0°C (32°F).

.24 **General Alarm:**

- .1 High/low HGS temperature.
- .2 High/low local differential pressure.

.25 **Maintenance Alarms:**

- .1 Pump status is "ON" and command is "OFF."
- .2 Manual overrides placed on system.

.26 **Trends:**

- .1 All inputs and outputs will be trended at 30-minute intervals for and stored for 3 days, at the end of each day the oldest day's data will be automatically deleted.
- .2 Certain trends shall not automatically delete and shall be saved indefinitely until the user decided to delete the data, those trends shall be as follows:
  - .1 HGS and HGR set point and reading.
  - .2 Differential pressure set point and reading.
  - .3 Remote differential pressure set point and reading.
  - .4 Daily, weekly, and monthly energy consumption.

1.14 **HEATING GLYCOL PUMP CONTROL (P-1 A/B)**

- .1 General

- .1 The heating glycol pump system will operate by signals received from the BMS.
- .2 The system shall operate in a duty/ standby pump configuration.
- .2 Enable / disable (initial startup)
  - .1 The BMS shall send a signal to enable the heating glycol pump(s).
  - .2 Else; the heating glycol pump(s) shall remain disabled.
- .3 Upon a signal from the BMS to start a pump.
  - .1 Start modulation the speed on the duty heating glycol pump. Pump starting order shall be determined by the BMS.
  - .2 Modulate the heating glycol bypass valve to maintain the heating water system flow 10% above the minimum required flow rate for a single pump to operate.
- .4 System differential pressure transmitters
  - .1 Differential pressure transmitters in heating glycol branches shall provide a signal for pump speed control.
  - .2 Actual setpoint shall be optimized by the TAB contractor and field verified by the commissioning agent.
- .5 Order of operation
  - .1 The actual order of operation is the order the BMS uses to determine which pump is started or stopped next. Actual order shall be based on the order of priority. The order of priority shall be as follows:
    - .1 Operator override.
    - .2 Run hours.
    - .3 On the heating glycol system control screen (or sub-screen), create a schedule showing the order of heating glycol pump operation. The schedule shall include the following fields:
      - .1 Heating glycol pump - each line will display the heating glycol pump tag identification.
      - .2 Actual order of operation - each line will display the order the BMS uses to determine which pumps is started or stopped next. (i.e. 1,2)
      - .3 Operator override order - this field is the only line the operator can enter values into the table. (i.e. 1,2)
      - .4 Changes are updated when the operator selects the button to update the table.
      - .5 Run hour order - this field is determined by the BMS in order to operate the pump with the least run hours first. Pump run order is predetermined at the same time every week. The adjustable default time for the BMS to determine the weekly run order shall be 8am each Thursday.
      - .6 Run hours - this field displays the run hours that are calculated and tracked by the BMS as cumulative hours of operation since the initial start-up.
      - .7 Status - this field shall display the status of each pump (i.e., Run / Off / Alarm).
      - .8 If the pump status is indicated as "Alarm", the BMS shall consider the pump not available, and the next pump in order will be started.

- When the alarm is cleared, the operator can select "Update Table" to reset the pump status.
- .9 Pump speed - this field shall display the pump speed that is signaled from the pump VFD. The speed shall be reported in percentage (0% - 100%).
  - .10 Operating KW - this field shall display the pump operating power that is signaled from the pump VFD.
- .6 System differential pressure (DP)
- .1 If "DPSENSOR" < "DPSETPOINT"; increase pump speed.
  - .2 Elseif "DPSENSOR" > "DPSETPOINT"; decrease pump speed.
  - .3 Endif.
- .7 Operational range
- .1 The pumps shall be soft started from off and operate from 25%-100% speed via the variable frequency drives to maintain the differential pressure setpoint. VFD's shall not operate below 17HZ (low limit speed shall be verified by the controls contractor with the installed pump selections surge curve).
- .8 Pump failure / fault
- .1 If either the pumps fail to start or issues an alarm due to a fault; the failed pump shall be locked out of operation and the redundant pump shall be started.
  - .2 The original remaining operating pump shall be designated the duty pump and the redundant pump shall become the standby pump.
- .9 Pump Rotation
- .1 If the scheduled pump rotation results in starting a new pump that is not currently in operation; the new pump shall be started before shutting down the operating pump.
- .10 Pressure Reset
- .1 Trim and respond reset (pump differential pressure reset option #1)
    - .1 Using this option #1, the differential pressure setpoint is reset based on requests made by the hydronic system.
  - .2 Critical zone reset (pump differential pressure reset option #2)
    - .1 Using this option #2, the differential pressure setpoint is reset based on polling heating glycol valve position. The heating glycol valves shall send their position to the pump controller.
  - .3 Pump differential pressure reset shall be determined as follows:
    - .1 If 'Any Valve' position > 95%; the differential pressure setpoint shall be increased by 0.1 psi at a frequency of every 5 minutes.
    - .2 Elseif 'All Valve' positions <90%; the differential pressure setpoint shall be decreased by 0.1 psi at a frequency of every 5 minutes.
    - .3 Endif
  - .4 The differential pressure setpoint, reset increment amount, and frequency of reset shall be optimized in the field by the TAB contractor and commissioning agent.

- .11 Building heating glycol temperature alarm
  - .1 Temperature alarm as sensed by the building heating glycol supply/ return temperature sensor
    - .1 level 3 alarm: if 10°F above or below setpoint for 10 minutes, generate a level 3 alarm at the bas & graphic user interface.
    - .2 level 2 alarm: if 15°F above or below setpoint for 10 minutes, generate a level 2 alarm at the bas & graphic user interface.
- .12 Building heating glycol pressure alarm
  - .1 Pressure alarm as sensed by the building heating glycol supply/ return pressure sensor
    - .1 level 3 alarm: if 5 psi above or below setpoint for 10 minutes, generate a level 3 alarm at the bas & graphic user interface.
    - .2 level 2 alarm: if 10 psi above or below setpoint for 10 minutes, generate a level 2 alarm at the bas & graphic user interface.
- .13 Variable frequency drive fault alarm
  - .1 Faults generated by an associated variable frequency drive, de-energize associated pump(s).
  - .2 Level 2 alarm: upon report of a fault
    - .1 Deenergize the associated pump(s).
    - .2 Alarm shall be provided.
- .14 Glycol Fill fault/ Pressure alarm
  - .1 Faults generated by an associated makeup glycol system; low pressure alarm generate:
    - .1 Level 2 alarm: upon report of a fault
      - .1 Deenergize the associated pump(s).
      - .2 Alarm shall be provided.
- .15 Loss of power
  - .1 Upon loss of power, valves, etc. Shall return to their fail safe positions.
  - .2 Upon restoration of power; the pump shall have a delay of 60 seconds prior to restart.
    - .1 All pumps shall provide a staggered start operation to minimize electrical demand surge during restart.

#### 1.15 CHILLED GLYCOL PLANT

- .1 **General:**
  - .1 The chilled glycol system is composed of the following equipment to generate and distribute chilled water/glycol to the facility:
    - .1 Three (3) heat recovery chiller (duty/duty/standby).
    - .2 Two (2) variable primary chilled glycol pumps (duty/standby).
  - .2 The system provides chilled glycol to the air handling units. The system provides chilled water to the fan coils and computer room air conditioning units.

- .3 Both the chilled glycol and chilled water distribution loops are variable flow (the chillers are heat recovery chillers shall be capable of variable flow).
- .4 Flow meters and temperature sensor shall be provided throughout to allow the BAS the able to monitor and control system flow.
- .5 The BAS will interface with the chillers/heat recovery via BACnet gateway. Additional points will be provided on the BAS so that all OEM points can be controlled and monitored.
- .2 **Safeties and Limits:**
  - .1 The chiller is equipped with factory mounted hardwired safety limits.
  - .2 Isolating valves are interlocked with the chiller and pumps via the DDC controller. For any pump to be enabled a flow path must exist (one valve proven open). For a chiller to be enabled its associated valve must prove open. Note that an operator must prove a flow path manually prior to operating any pump in 'hand' mode.
  - .3 Minimum run times are provided for the chiller and pumps.
  - .4 Pump speed control is disabled (pumps run at minimum speed) until pump run status is received.
  - .5 Minimum pump speed for a variable speed pump is 18 Hz.
  - .6 If a pump fails (commanded "ON" and status not received – 1 minute delay), an alarm will be issued, and the other pump started. Command to the failed pump will remain "ON". Pump failure will be cleared by the controller (alarm still archived on the BAS) once pump run status has been on for more than 1 minute.
  - .7 If the remote differential pressure sensor is not reading (or network is down) the system will default to a local pressure set point of 175 kPa (25.4 psi).
  - .8 The minimum flow to the system is set based on the minimum flow to the chiller. Confirm value with the chiller Manufacturer.
- .3 **Alternation of Equipment:**
  - .1 Pumps pairs will be alternated between duty and standby on a weekly basis to maintain equal runtimes. If a single pump is running, the system will start the new duty pump and confirm operation before shutting down the old duty pump.
  - .2 Chillers will be alternated between duty and standby on a weekly basis to maintain equal runtimes. If one or two chillers are running, the system will start the new lead chiller and confirm operation before shutting down the old chiller.
- .4 **Modes of Operation:**
  - .1 The cooling plant will be seasonally enabled/disabled manually by the operator through a graphical button on the BAS. When seasonally enabled, the system will operate as described. When seasonally disabled, the system will stay in the disabled mode. The mode of the cooling system is set manually by the operator and that mode is shared over the BAS network to the chilled water plant controller.
  - .2 When the outdoor air temperature is above 15°C (59°F) and a run request is received the system will be enabled to run. They system will be disabled when no run requests have been received for more than 30 minutes. Run requests are generated when a cooling valve is commanded open (at least 1%). Run requests are disabled once the valve has been closed for 5 minutes.
- .5 **Enable Mode:**

- .1 Overview: The chiller will control to maintain the return water temperature at set point. The pumps will control to minimize the pumping energy while ensuring water is available at all points in the facility.
- .2 Chilled Glycol Returning Temperature Setpoint Reset: The base set point will be reset from 14°C to 18°C (58°F to 65°F) as the outdoor air temperature drops from 30°C to 15°C (86°F to 59°F). The actual set point will be equal to the base set point +/- an offset. The offset will range between - 2°C and + 2°C (-4°F to +4°F). When a cooling request is received the offset will increase 1°C (2°F) every 10 minutes. When no cooling requests are received the offset will decrease 1°C (2°F) every 20 minutes. Cooling requests are generated when a cooling valve is 90% open. The request is reset once the valve is less than 80 % open. Regardless of the offset calculation the minimum set point will be 14°C (58°F) and the maximum will be 18°C (65°F).
- .3 Differential Pressure Setpoint Reset: The local differential pressure set point will be automatically reset between 100 kPa and 200 kPa (14.5 psi to 29 psi) to maintain the remote DP sensor at 40 kPa (5.8 psi).
- .4 Distribution Pumps: The duty glycol chilled water pump will run continuously. Pump speed is controlled to maintain the local differential pressure at set point.
- .5 Heat Recovery Chiller: The heat recovery chiller will operate as the primary source of cooling when a simultaneous demand for heat is present. The heat recovery chiller shall operate to maintain cooling setpoint and shall reject heat either into the heating glycol loop (when a demand for heating is present) or to the air-cooled condenser (when no demand for heating). Changeover shall happen automatically. Controls contractor to confirm/coordinate exact staging parameters with the procured heat recovery chiller manufacturer.
- .6 Waterside Economizer: The manufacturer supplied controller shall automatically determine if the conditions to economize have been met. Economizer function shall be always monitored by the BAS. The BAS shall be capable of disabling the economizer if desired by the building operator.
- .6 **Disabled Mode:**
  - .1 Overview: The system is off.
  - .2 Distribution Pumps: The pumps are off.
  - .3 Chillers + Isolating Valves: Both chillers are off. The chiller isolating valves are open.
- .7 **Integration with Other Systems:**
  - .1 The outside air temperature is shared over the BAS network.
  - .2 Run requests are received via the network from dependent systems. They are sent to the cooling plant when a cooling valve is open 1% or more. The run request is reset once the valve has been closed for more than 5 minutes.
  - .3 Cooling requests are received via the network from dependent systems. They are sent to the cooling plant when the cooling valve is open more than 90%. The cooling request is reset once the valve is less than 80% open.
  - .4 The controller will share the seasonal status of the cooling plant to allow all cooling control valves to relax (spring relief).
- .8 **Critical Alarms:**
  - .1 Pump failure;
  - .2 Chiller failure.

- .3 The system is seasonally disabled once the outdoor air temperature rises above 25°C (77°F).

.9 **General Alarms:**

- .1 High/low glycol chilled supply temperature.
- .2 High/low local differential pressure.
- .3 Chiller alarms as provided through the BACnet interface.

.10 **Maintenance Alarms:**

- .1 Pump status is on and command is off.
- .2 Manual overrides placed on system.

.11 **Trends:**

- .1 All inputs and outputs will be trended at 30 minute intervals for and stored for 3 days, at the end of each day the oldest day's data will be automatically deleted.
- .2 Certain trends shall not automatically delete and shall be saved indefinitely until the user decided to delete the data, those trends shall be as follows:
  - .1 CHGS and CHGR set point and reading.
  - .2 Differential pressure set point and reading.
  - .3 Remote differential pressure set point and reading.
  - .4 Daily, weekly and monthly energy consumption.

1.16 **CHILLED GLYCOL PUMP CONTROL (P-2 A/B)**

.1 General

- .1 The chilled glycol system will operate by signals received from the BMS.
- .2 The system shall operate in a duty/ standby pump configuration.

.2 Enable / disable (initial startup)

- .1 The BMS shall send a signal to enable the chilled glycol pump(s).
- .2 Else; the chilled glycol pump(s) shall remain disabled.

.3 Upon a signal from the BMS to start a pump.

- .1 Start modulation the speed on the duty chilled glycol pump. Pump starting order shall be determined by the BMS.

.4 Order of operation

- .1 The actual order of operation is the order the BMS uses to determine which pump is started or stopped next. Actual order shall be based on the order of priority. The order of priority shall be as follows:
  - .1 Operator override.
  - .2 Run hours.
  - .3 On the chilled glycol pump system control screen (or sub-screen), create a schedule showing the order of chilled glycol pump operation. The schedule shall include the following fields:
    - .1 chilled glycol pump - each line will display the chilled glycol pump tag identification.

- .2 Actual order of operation - each line will display the order the BMS uses to determine which pumps is started or stopped next. (i.e. 1,2)
- .3 Operator override order - this field is the only line the operator can enter values into the table. (i.e. 1,2)
- .4 Changes are updated when the operator selects the button to update the table.
- .5 Run hour order - this field is determined by the BMS in order to operate the pump with the least run hours first. Pump run order is predetermined at the same time every week. The adjustable default time for the BMS to determine the weekly run order shall be 8am each Thursday.
- .6 Run hours - this field displays the run hours that are calculated and tracked by the BMS as cumulative hours of operation since the initial start-up.
- .7 Status - this field shall display the status of each pump (i.e. Run / Off / Alarm).
- .8 If the pump status is indicated as "Alarm", the BMS shall consider the pump not available, and the next pump in order will be started. When the alarm is cleared, the operator can select "Update Table" to reset the pump status.
- .9 Pump speed - this field shall display the pump speed that is signaled from the pump VFD. The speed shall be reported in percentage (0% - 100%).
- .10 Operating KW - this field shall display the pump operating power that is signaled from the pump VFD.
- .5 Operational range
  - .1 The pumps shall be soft started from off and operate from 25%-100% speed via the variable frequency drives to maintain the differential pressure setpoint. VFD's shall not operate below 17HZ (low limit speed shall be verified by the controls contractor with the installed pump selections surge curve).
- .6 Pump failure / fault
  - .1 If either the pumps fail to start or issues an alarm due to a fault; the failed pump shall be locked out of operation and the redundant pump shall be started.
  - .2 The original remaining operating pump shall be designated the duty pump and the redundant pump shall become the standby pump.
- .7 Pump rotation
  - .1 If the scheduled pump rotation results in starting a new pump that is not currently in operation; the new pump shall be started before shutting down the operating pump.
- .8 Pressure reset
  - .1 Trim and respond reset (pump differential pressure reset option #1)
    - .1 Using this option #1, the differential pressure setpoint is reset based on requests made by the chilled glycol system.
  - .2 Critical zone reset (pump differential pressure reset option #2)
    - .1 Using this option #2, the differential pressure setpoint is reset based on polling chilled water valve position. Chilled glycol valves shall send their position to the pump controller.



- .2 Pump differential pressure reset shall be determined as follows:
    - .3 If 'Any Valve' position > 95%; the differential pressure setpoint shall be increased by 0.1 psi at a frequency of every 5 minutes.
    - .4 Elseif 'All Valve' positions <90%; the differential pressure setpoint shall be decreased by 0.1 psi at a frequency of every 5 minutes.
    - .5 Endif
  - .3 The differential pressure setpoint, reset increment amount, and frequency of reset shall be optimized in the field by the TAB contractor and commissioning agent.
- .9 Chilled Glycol temperature alarm
  - .1 Temperature alarm as sensed by the chilled glycol supply or return temperature sensor.
    - .1 level 3 alarm: if 5°F above or below setpoint for 10 minutes, generate a level 3 alarm at the bas & graphic user interface.
    - .2 level 2 alarm: if 10°F above or below setpoint for 10 minutes, generate a level 2 alarm at the bas & graphic user interface.
- .10 Chilled Glycol pressure alarm
  - .1 Pressure alarm as sensed by the chilled glycol across the pressure sensor.
    - .1 level 3 alarm: if 5 psi above or below setpoint for 10 minutes, generate a level 3 alarm at the bas & graphic user interface.
    - .2 level 2 alarm: if 10 psi above or below setpoint for 10 minutes, generate a level 2 alarm at the bas & graphic user interface
- .11 Variable frequency drive fault alarm
  - .1 Faults generated by an associated variable frequency drive, de-energize associated pump(s).
    - .1 Level 2 alarm: upon report of a fault
      - .1 Deenergize the associated pump(s).
      - .2 Alarm shall be provided.
- .12 Loss of power
  - .1 Upon loss of power, valves, etc. Shall return to their fail-safe positions.
  - .2 Upon restoration of power, the pump shall have a delay of 60 seconds prior to restart.
    - .1 All pumps shall provide a staggered start operation to minimize electrical demand surge during restart.
- 1.17 **COMPUTER ROOM AIR CONDITIONING (CRAC), IT ROOM (116):**
  - .1 General
    - .1 Units shall operate continuously as required to maintain space temperature and humidity conditions.
    - .2 The units shall operate as N+1 redundancy.
    - .3 The units are self-contained CRAC units.
    - .4 Controls described herein shall be performed by the manufacturer's unit mounted controller using electric actuation and PID control logic.

- .5 Provide all interface, wiring, relays, interlocks, controls, and programming as required for interfacing and operation of the CRAC units pre-packaged control system.
- .6 Unit shall generally consist of the following:
  - .1 Supply fan(s) with variable speed control
  - .2 Chilled glycol coil (connected to building chilled glycol system)
  - .3 Electric Reheat Coil
  - .4 Humidifier
  - .5 Air filters
  - .6 All required sensors and transmitters
  - .7 Pre-packaged control system
  - .8 BACNET IP network interface for monitoring unit operation and performance
  - .9 Operation and interlock of external motorized damper/s and fire suppression system
- .2 The CRAC unit control panel shall communicate virtual points to the BMS. Selected virtual points shall be mapped to the BMS and shall be readable and/or writeable through the CRAC-to-BMS serial BACNET IP ethernet connection cable.
- .3 The BMS shall monitor temperatures, humidity, status, duty assignment override, setpoints, etc. from the CRAC unit's controller through the BACNET serial link or ethernet connection
- .4 If communication is lost with the BMS, the unit controller shall operate using its last communicated setpoints and run command and an alarm shall be generated. In the event of lost communication, the lead unit (or master unit) shall be switched to the redundant unit to allow for communication with the BMS.
- .5 Scheduling
  - .1 System shall be scheduled and enabled to operate continuously (24 hours per day).
- .6 Space conditioning setpoints (adjustable)
  - .1 Temperature setpoint: 86°F ±5°F
  - .2 Temperature deadband: 4°F
  - .3 Humidity: 45% +5%
- .7 Startup / shutdown
  - .1 Startup and shutdown shall be sequenced by the CRAC unit manufacturer packaged control system.
  - .2 The chilled glycol coil (connected to building chilled glycol system) shall normally operate.
  - .3 The humidifier and reheat coil shall normally operate.
  - .4 The CRAC unit manufacturer packaged controls shall operate the unit fan speed control.
  - .5 The packaged controls shall operate the fan speed as required to optimize the operation for cooling, heating operation.
  - .6 Provide adequate deadband to prevent short cycling of the unit.
- .8 N+1 unit operation

- .1 CRAC units are installed in an N+1 configuration, the design intent is for all units to operate simultaneously (based on the temperature requirements of the nearby rack mounted temperature sensor). When a unit fails, the other units shall stage up accordingly to compensate for the lost capacity.
- .2 If the space temperature signals a high space temperature alarm:
  - .1 level 3 alarm: refer to alarms section.
- .9 Loss of power
  - .1 The unit shall be programmed to allow for an automatic restart upon a power failure and restoration of power.
  - .2 The unit shall return to the status and operation being performed prior to the power failure.
- .10 Alarms and events
  - .1 Space/zone temperature alarm
    - .1 High-temperature alarm as sensed by the space air temperature sensor.
      - .1 level 3 alarm: if the space/zone is 5°F above cooling upper limit setpoint for 10 minutes, generate a level 3 alarm at the BMS & graphic user interface.
      - .2 level 2 alarm: if the space/zone is 15°F above cooling upper limit setpoint for 10 minutes, generate a level 2 alarm at the BMS & graphic user interface.
    - .2 Low-temperature alarm as sensed by the space air temperature sensor.
      - .1 level 3 alarm: if the space/zone is 5°F below heating lower limit setpoint for 10 minutes, generate a level 3 alarm at the BMS & graphic user interface.
      - .2 level 2 alarm: if the space/zone is 15°F below heating lower limit setpoint for 10 minutes, generate a level 2 alarm at the BMS & graphic user interface.
  - .2 Space/zone humidity alarm
    - .1 High-humidity alarm as sensed by the space humidity sensor.
      - .1 level 3 alarm: if the space/zone is 2% above the upper limit setpoint for 10 minutes, generate a level 3 alarm at the BMS & graphic user interface.
      - .2 level 2 alarm: if the space/zone is 5% above the upper limit setpoint for 10 minutes, generate a level 2 alarm at the BMS & graphic user interface.
  - .3 Standby unit alarms
    - .1 Level 3 alarm: if the standby unit is enabled; generate a level 3 alarm at the BMS & graphic user interface.
  - .4 Short cycle alarm
    - .1 Level 4 alarm: if the CRAC unit exceeds 10 starts within a 1-hour time period; generate a level 4 alarm at the BAS & graphic user interface.
  - .5 Unit general fault alarm
    - .1 Level 2 alarm: if the unit signals a general fault; generate a level 2 alarm at the BMS & graphic user interface.

- .6 Loss of power
  - .1 Level 2 alarm: if the unit signals a loss of power alarm; generate a level 2 alarm at the BAS & graphic user interface.
- .7 BMS disconnection alarm
  - .1 Level 3 alarm: if the BMS signals connection has been lost between the building control system and the packaged unit controls system; generate a level 3 alarm at the BMS & graphic user interface.
- .8 Fire suppression interface:
  - .1 Server Room is equipped with Clean Agent fire suppression systems.
  - .2 Upon Clean Agent fire suppression systems signal:
    - .1 AC/ air handling units and humidifier units shall be turned off (enabling Clean Agent fire suppression systems activation/ discharge)
    - .2 Close all motorized dampers of all perimeter openings into the space.
    - .3 Monitor differential pressure between room and corridor, open motorized damper in transfer air duct to relieve pressure inside room if pressure exceeds the wall's maximum allowable limit.
  - .3 Reverse to normal operation upon fire suppression systems signal release.
- .9 Loss of power:
  - .1 The unit shall be programmed to allow for an automatic restart upon a power failure and restoration of power.
  - .2 The unit shall return to the status and operation being performed prior to the power failure.

#### 1.18 CABINET, FORCED FLOW AND UNIT HEATER CONTROL

- .1 General:
  - .1 The heater shall operate intermittently as required to maintain space temperature.
  - .2 Controls described herein shall be performed by the unit mounted controller using electric actuation and either PI or PID control logic. PI or PID control shall be determined by the applications ability for control tuning. Provide all interface, wiring, relays, interlocks, controls, and programming as required for operation.
- .2 The heater shall generally consist of the following:
  - .1 Supply fan.
  - .2 Heating glycol control valve
  - .3 Air filter (cabinet, forced flow).
  - .4 All required sensors and transmitters.
  - .5 Multi speed Motor Starter
  - .6 Thermostat / controller
- .3 Building management system (BMS) interface:
  - .1 The BAS shall monitor temperatures and setpoints from the cabinet unit heater controller.

- .2 If communication is lost with the BMS, the unit controller shall operate using its last communicated setpoints and run command and an alarm shall be generated.
- .4 Scheduling:
  - .1 The heaters shall be programmed to be capable of operating in two occupancy modes. The occupancy mode shall be determined through a user-adjusted, graphical, seven-day schedule with a holiday schedule.
  - .2 The occupancy modes are described as follows:
    - .1 Occupied: all heaters shall be programmed to operate in the occupied mode continuously (24 hours per day).
    - .2 Unoccupied: an optional unoccupied mode shall be made available to the users within the building management system
- .5 Space temperature setpoints:
  - .1 During occupied mode, maintain the following heating space temperature conditions:
    - .1 Stairwells: space temperature set point of 68°F, adjustable.
    - .2 Vestibules: space temperature set point of 68°F, adjustable
    - .3 Other areas: operator selected.
- .6 Fan start/stop control:
  - .1 On call to run for heating, energize the cabinet unit heater fan to run.
  - .2 Simultaneously, the heating glycol control valve shall modulate open.
  - .3 Once space temperature has been satisfied; the fan shall be de-energized, and the heating water control valve shall modulate closed.
  - .4 Fan minimum "On/Off":
    - .1 The supply fan shall have a minimum time setting for fan "On" and fan "Off" to prevent short cycling the fan operation.
    - .2 Provide adequate deadband to reduce cycling of fan operation.
- .7 Heating:
  - .1 On a fall in space temperature below set point, modulate the heating water control valve towards the open position.
  - .2 On a rise in space temperature, modulate the heating water control valve towards the closed position.
- .8 Alarms
  - .1 Unit heater fan failure alarm:
    - .1 Level 2 alarm: on failure to run, disable the unit heater fan and send an alarm to the building control system. Generate a level 2 alarm at the BAS & graphic user interface.
  - .2 Space/zone temperature alarm:
    - .1 Low-temperature alarm
      - .1 level 3 alarm: if the space/zone is 10°F below heating lower limit setpoint for 10 minutes, generate a level 3 alarm at the BAS & graphic user interface.

- .2 level 2 alarm: if the space/zone is 20°F below heating lower limit setpoint for 10 minutes, generate a level 2 alarm at the BAS & graphic user interface.
- .3 Low-temperature alarms shall be suppressed in the following conditions:
  - .1 heating system status of 'Systemok' is reported as 'False.'
  - .2 BMS disconnection alarm
- .9 Loss of power:
  - .1 The cabinet unit heater shall be programmed to allow for an automatic restart upon a power failure and restoration of power.
  - .2 The unit shall return to the status and operation being performed prior to the power failure.

#### 1.19 DOMESTIC WATER HEATER

- .1 General:
  - .1 Self-contained instantaneous domestic hot water heater.
- .2 Scheduling:
  - .1 Continuous operation when building is occupied.
- .3 Temperature:
  - .1 Monitor and trend domestic water discharge temperature.
- .4 Alarms:
  - .1 Discharge temperature alarm
    - .1 Level 3 alarm: if the system discharge temperature drops 10F below setpoint for 5 minutes, send an alarm to the building control system. Generate a level 3 alarm at the BAS & graphic user interface.
  - .2 BMS disconnection alarm
- .5 Loss of power:
  - .1 The unit shall be programmed to allow for an automatic restart upon a power failure and restoration of power.
  - .2 The unit shall return to the status and operation being performed prior to the power failure.

#### 1.20 FLOW / ENERGY METERING

- .1 Operation
  - .1 The natural gas meter will be monitored through pulse output provided with the meter.
  - .2 The water meter will be monitored through pulse output provided with the meter.
  - .3 Hot water and chilled water energy metering
  - .4 Calculate total energy from supply water temperature entering the building and return water temperatures leaving the building and the water flow meter through the building.
    - .1 Calculate total energy from supply water temperature entering, return water temperatures leaving and the water flow meter through all other submetering area/ systems and per LEED and PA Schedule 38 requirements.

- .5 Electrical sub metering utilizing VFDs
- .2 BAS points
  - .1 The following points shall be monitored by the BAS:
    - .1 kW
    - .2 kW\*hr
    - .3 PF
    - .4 Gas usage rate
    - .5 Water usage rate
    - .6 Hot water, Chilled water energy
  - .3 Alarms
    - .1 Use adjustable high and low alarm limits shall be programmed for all monitored variables.
    - .2 Flow Meter failure:
      - .1 Level 2 alarm: Generate a level 2 alarm at the BAS & graphic user interface.
    - .3 BMS disconnection alarm

**END OF SECTION**

## 1 General

### 1.1 REFERENCE

1. Division 00 and Division 01 apply to and are a part of each Electrical Division Section.

### 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 of Electrical Divisions and is to be read accordingly.
2. Be responsible for advising product vendors of requirements of this Section.

### 1.3 SUBMITTALS

1. Submit shop drawings for products of this Section.
2. Additionally, as part of shop drawing submission process, submit following to Consultant for review:
  1. dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for Electrical Divisions work;
  2. samples of materials and any other items as specified in succeeding Sections of Electrical Divisions;
  3. weight loads of selected equipment (upon request);
  4. equipment nameplate and warning sign proposed nomenclature, print type, symbols, sizing and colours;
  5. fire stopping installation drawings with ULC certifications;
  6. copies of prior to start of construction approvals from local governing authorities having jurisdiction.
3. Prior to application for Substantial Performance of the Work, submit following to Consultant for review (note: funds will be withheld until each of following items have been completed and documented to satisfaction of Owner and reviewed with Consultant):
  1. fire alarm system testing and verification report of each component of work; devices to be certified working and in proper order;
  2. final distribution system testing and arc flash study performed and documented to satisfaction of Consultant;
  3. structured network cabling system tested and verified to be operating and performing in accordance with specified standards.

## 2 Products

### 2.1 DUCT FOR DIRECT BURIED CABLES

1. DB/2 solid wall rigid PVC duct and fittings, CSA Certified, tested to CSA Standard C22.2 No. 211.1.
2. Synthetic polypropylene fibre (plastic) twine cord or 19 mm (3/4") diameter polyethylene rope, and where required approved by local governing Utility.

### 2.2 CONDUITS

1. EMT (Thinwall), galvanized electrical metallic tubing to CSA C22.2 No. 83, complete with factory made bends where site bending is not possible and joints and terminations made with steel couplers and steel set screw type connectors with insulated throats, and concrete tight where required by local governing codes. Provide raintight type fittings where EMT is exposed to water spray of activated sprinklers.



2. Rigid galvanized steel to CSA C22.2 No. 45, with exterior zinc and interior enamel coatings, galvanized threads where factory cut and red lead coated threads where site cut. Factory made bends where site bending is not possible, factory made and threaded fittings, and connectors, and terminations with rigid couplings, and concrete tight where required.
3. Hot dipped zinc galvanized steel core, flexible liquid tight metallic conduit to CSA C22.2 No. 56, with flame retardant PVC jacket, complete with terminations consisting of ULC listed, suitable for wet locations, gasketed, steel or iron construction, liquid-tight flexible conduit connectors at terminations.
4. CSA approved and labelled, FT-4 rated, rigid plastic (PVC) conduit complete with site made heat gun bends on conduit to 50 mm (2") diameter, factory made elbows in conduit larger than 50 mm (2") diameter, solvent weld joints, factory made expansion joints where required, and terminations made with proper and suitable connectors and adaptors.

### 2.3 OUTLET BOXES

1. CSA approved stamped galvanized steel outlet boxes.
2. Each outlet box and back box to be suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers, carpet flanges and any other required accessory.
3. Electrical boxes exposed exterior of building or in non-climate controlled locations to be weatherproof boxes complete with gasketed covers/faceplates.

### 2.4 PULLBOXES AND JUNCTION BOXES

1. Galvanized or prime coat plated steel, suitable in respects for application and complete with screw-on or hinged covers as required, and connectors suitable for connected conduit.
2. Eaton Crouse-Hinds, "Condulet", threaded cast Feraloy outlet boxes of an exact type to suit application, each complete with screw-on gasketed cover.
3. Rigid plastic (PVC), CSA certified, junction boxes and access fittings with solvent weld type joints and screw-on PVC covers.
4. Physical size of pullboxes to be as required by local governing electrical code to suit number and size of conduits and conductors.
5. Each box to be suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.
6. Boxes exposed exterior of building or in non-climate-controlled locations to be weatherproof boxes complete with gasketed covers.

### 2.5 SLEEVES

1. Galvanized steel sleeves as follows:
  1. No. 24 gauge with an integral flange at one (1) end to secure sleeve to formwork construction;
  2. Schedule 40 pipe.
2. Schedule 40 PVC sleeves.

### 2.6 FIRESTOPPING AND SMOKE SEAL MATERIALS

1. Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN/ULC S115, and CAN/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) no less than fire rating for surrounding 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. Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
5. For typical standard indoor applications for conduit and cable installations to seal openings up to 25 mm (1"): Hilti "Cable Disc CFS-D 1", pre-formed firestopping solution with features as follows:
  1. Approximate Density 1.6 g/cm<sup>3</sup>;
  2. Mold and mildew resistant;
  3. Surface burning characteristics (UL 723 (ASTM E84): Flame spread: 0 and Smoke development: 5;
  4. Application temperature 0 to 40°C (32-104°F);
  5. Percent Fill: up to 100% per tested system;
  6. Sound Transmission classification (ASTM E 90): 62 (Relates to specific construction).
6. For typical standard indoor applications to seal openings up to 1800 mm x 900 mm (72" x 36"): Hilti "Firestop Block (CFS-BL)", ready-to-use, intumescent flexible block designed for:
  1. Sealing single or multiple penetrations of openings;
  2. Temporary or permanent sealing of cables and cable tray penetrations;
  3. Temporary or permanent sealing of conduit penetrations.
7. Firestop Block (CFS-BL) features as follows:
  1. Tested in accordance with CAN/ULC-S115, UL 1479, ASTM E 814 and ASTM E 84;
  2. Halogen, asbestos, solvent free and smoke resistant;
  3. Operational immediately after installation;
  4. Application temperature 5°C to 40°C (40°F to 104°F);
  5. Temperature resistance -15°C to 60°C (5°F to 140°F);
  6. Intumescent activation approximately 200°C (392°F);
  7. Expansion ratio (unrestricted) Up to 1:3;
  8. Surface burning characteristics (ASTM E 84-10b): Flame Spread Index: 10 and Smoke Development Index: 15;
  9. Sound transmission classification (ASTM E 90): STC Rating: 52;
  10. Suitable for wet areas when applied with additional silicone coating to manufacturer's directions.
8. Supply products of a single manufacturer for use on work of this Division.
9. Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
10. 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.
11. 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".
12. Acceptable manufacturers are:
  1. Hilti Canada;

2. Specified Technologies Inc.;
3. 3M Canada Inc.;
4. Tremco;
5. A/D Fire Protection Systems;
6. Nelson.

## 2.7 FASTENING AND SECURING HARDWARE

1. Concrete inserts - Crane Canada Ltd., No. 4-M for concrete work for single or double conduit, cable tray, etc., runs and equipment. Unistrut Ltd. multiple type inserts for runs of three (3) or more conduits etc., or where a grid support system is required.
2. Concrete fasteners – "WEJ-IT" anchors, lead cinch anchors and/or "STAR" or "PHILLIPS" self-drilling anchors.
3. Masonry inserts – "WEJ-IT" expansion shields and machine bolts or, for light loads, fibre or lead plugs and screws.
4. Drywall or plaster wall and/or ceiling fasteners – 2-wing spring toggles.
5. Structural steel - Crane Canada Ltd., beam clamps.
6. Anchors, fasteners and other securing hardware to be of capacity and type to suit application and for which materials to which hardware are being installed. Include manufacturer's product literature with shop drawing submissions detailing that supplied hardware is suitable for respective applications. Arrange for manufacturer's representative to provide onsite installation training for hardware products.
7. Metal framing channels – typical 40 mm (1-5/8") width but increased where required to suit application, galvanized steel channels complete with required fittings and ancillary hardware. Acceptable manufacturers of framing channels are:
  1. Unistrut;
  2. Thomas & Betts;
  3. Hilti;
  4. Eaton B-Line.
8. Acceptable manufacturers of fastening and securing hardware:
  1. Crane;
  2. Hilti;
  3. Thomas & Betts.
9. Pentair Erico metal "J" hooks or Panduit "J-Pro" cable support systems for communications system cabling in accessible ceiling spaces where conduit or cable tray is not being provided. J hooks to be of type and size to maintaining cable minimum bending radii of cable being supported and have smooth edges that cannot damage cable. Clearly identify cable manufacturer's bending radii specifications and submit with shop drawings. Use of J-hooks is subject to approval from Owner and review with Consultant.
10. Velcro tie wraps for bundling and securing cables.

## 2.8 ACCESS DOORS

1. Access doors to be provided under work of Division 08 by General Trades Contractor.
2. Coordinate with Mechanical Contractor and General Trades Contractor to ensure that access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and that work involving both mechanical and electrical services to where possible be accessible from common access door. Coordinate work to ensure that same common location access doors are not supplied by more than one Division.

3. Size access door to suit 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. 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.
5. Identify on reflected ceiling plans and wall elevation drawings, coordinated locations of proposed access door locations and submit to Consultant for review.

## 2.9 IDENTIFICATION NAMEPLATES

1. Laminated plastic (Lamacoid) black-white-black with bevelled edges, stainless steel screws, and proper identification engraving. Each nameplate to be sized to suit equipment for which it is provided and required wording. Various colour configurations to be used to differentiate systems. Confirm exact nomenclature, sizing, print type and colour scheme with Owner and review with Consultant.
2. Brother "P-Touch" or approved equal, portable electronic labelling system complete with self-adhesive, permanent printed labels with required nomenclature.
3. For non-climate-controlled areas: nameplates to be weather resistant, corrosion resistant and UV resistant to prevent fading. Mounting hardware to be corrosion resistant stainless-steel construction.

## 2.10 SIGNAGE

1. Thomas & Betts Ltd., or approved equal, semi-rigid vinyl panels with drilled holes in each corner, stainless steel screws, pressure sensitive mounting pads on back, and required printed wording. Generally, wording to be red on a white background with black trim confirmed with Owner and reviewed with Consultant.
2. For non-climate-controlled areas: signage to be weather resistant, corrosion resistant and UV resistant to prevent fading. Mounting hardware to be corrosion resistant stainless-steel construction.
3. Warning signage to comply with applicable requirements of local governing authorities and codes.

## 2.11 SYSTEM BACKBOARDS

1. FSC (Forest Stewardship Council), G1S (good one side) construction grade fir plywood, containing no added urea formaldehyde, flame retardant prime coat painted on exposed surfaces, minimum 20 mm (3/4") thick, as sized on drawings and with flame spread rating in accordance with local governing building code requirements.

## 2.12 MOTOR STARTER PANELS

1. Minimum No. 14 gauge sheet steel panels complete with steel angle reinforcing, framing and suitable splitter trough, fully primed and enamel painted, sized to accommodate starters required with spare space and capacity for at least two additional units.

## 2.13 SPRINKLER PROTECTION

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 reviewed with 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 protection" standards for equipment specified as NEMA / (EEMAC) 1, 2 or 12.
6. Obtain CSA approval where required by local governing authorities.

#### **2.14 ROOFTOP CONDUIT SUPPORT SYSTEM**

1. Cooper B-Line "Dura – Blok" series rooftop support systems with features as follows:
  1. CSA approved and/or ULC listed and labelled;
  2. non-penetrating of roof;
  3. vibration dampening;
  4. does not float;
  5. suitable for outdoor wet and freezing environments without damage caused by weather or freeze and thawing when exposed to de-icing chemicals;
  6. environmental friendly;
  7. constructed of recycled rubber.
2. Materials:
  1. Dura-Blok Curb base made of 100% recycled rubber and polyurethane pre-polymer with a uniform load capacity to suit specific load application of support (minimum 744 kg/m [500 pounds/linear foot]); each base to have a reflective red stripe.
  2. DB Series base: Dimensions: 150 mm (6") wide by 125 mm (5") tall by required overall length (minimum 225 mm [9"]); this is to be minimum dimensions, but base requirements must be increased to suit specific applications as recommended by system manufacturer; includes low base steel frame C channel 1.9 mm (14 gauge) – 25 mm (1") high strut galvanized per ASTM A653; and pipe roller assembly.
  3. DBE Series elevated: base with two 13 mm (1/2") dia electro zinc all threaded rod risers and 14 ga. 25 mm (1") high galvanized steel slotted channel; adjustable height up to 400 mm (16"); refer to drawings or confirm with Consultant for exact height requirements.
  4. Attaching hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633.
  5. Conduit clamps: single pipe supports constructed of galvanized steel and sized to accommodate sizing of installed conduits.
3. Confirm with system manufacturer that selected products provide proper support for application.
4. Acceptable manufacturers are as follows:
  1. Cooper B-Line;
  2. Clearline Technologies (C-Port);
  3. Erico (Caddy Pyramid).

### 3 Execution

#### 3.1 GENERAL INSTALLATION REQUIREMENTS

1. Install conduit concealed in finished areas and concealed to degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished areas such as Electrical and Mechanical Rooms, unless otherwise noted on drawings or specified herein. Refer to and examine architectural drawings and room finish schedules to determine finished, partially finished or unfinished areas of building. Documents do not identify exact routing. Where shown, routing is diagrammatic, identifying general requirements of routing and locations. Include for necessary offsets, fittings, transformations and similar items required as a result of obstructions and other architectural or structural details not shown.
2. Where conduits are exposed, arrange them to avoid interference with other work, parallel to building lines and install as high as possible. Do not install conduits within 150 mm (6") of "hot" pipes or equipment unless conduits are associated with equipment. Independently run conduit to be supported from wall/ceiling structure, not from ceiling hangers, ductwork, piping, cable trays, formed steel decking, etc. Do not run conduits within 900 mm (3') of equipment access opening covers.
3. Where conduit is proposed to be embedded within structural concrete, obtain Owner's approval and review with Consultant (Structural Engineer). Install such conduit in compliance with requirements of latest edition of CSA Standard CAN3-A23.1, "Concrete Materials, and Methods of Concrete Construction". Confirm and review with Structural Consultant, proper installation practices and methods. In areas where Consultant has directed conduit not to be embedded in concrete, run conduits through beams via sleeved openings pre-coordinated and reviewed with General Contractor and by Consultant (Structural Engineer). Do not embed conduit runs in concrete slab of parking garage areas, unless approved by Owner and reviewed with Consultant.
4. So as not to impair required strength of structure, following criteria to be generally followed but which is to be reviewed and coordinated with Consultant prior to start of Work:
  1. where conduits pass by a column, stay at least two times thickness of slab and drop away from column;
  2. where conduits terminate adjacent to a column or wall, bring conduit in toward column/wall as close to 90° to face of column as possible within two times thickness of slab and drop away from column;
  3. maximum size of conduit in structural slabs is 1/5 of solid portion of slab thickness;
  4. where more than two conduits are adjacent to each other, they are to be spaced greater of 3 diameters or 100 mm (4") apart;
  5. total of depth of conduits crossing over each other is to be less than one-third thickness of slab;
  6. place conduit in middle third of thickness of slab; do not lay conduit directly on reinforcing steel;
  7. do not run conduit adjacent to parallel reinforcing bars;
  8. do not run conduit longitudinally in beam without approval of Owner and review with Consultant; pass through beams at right angles to span of beam;
  9. where conduits pass through beams, maintain at least twice depth of beam separation away from supports;
  10. do not run conduits in slab beside a drop or beam within twice depth of slab from edge of drop or beam;
  11. do not run conduits through shear walls or columns without approval of Owner and review with Consultant;
  12. do not place conduit in structural elements in parking garage structures, water retaining structures or structures subjected to de-icing chemicals, without approval of Owner and review with Consultant.

5. For proposed use of conduit runs underground below slab include following provisions:
  1. concrete encased ductbank with conduits of non-ferrous materials and sloped to drain properly into pit;
  2. proper drain pit;
  3. system to be a pull-in system;
  4. 20% spare conduits (with minimum of at least 1);
  5. system proposal to consider and address any effects of magnetic fields.
6. Conduits are sized on drawings, but in absence of type and sizing, type and size to suit intended application in accordance with applicable local governing electrical code requirements. Sizes identified on drawings are minimum sizes and are not to be decreased unless approved by Owner and reviewed with Consultant.
7. Where receptacle type devices are located in existing floors and/or where feeds are required to furniture systems in open spaces, and where chasing of floor slab to run conduit is not acceptable to Owner, after review with Consultant provide fire rated "poke-thru" assembly installed through floor and feed from conduit runs provided in ceiling space of floor below.
8. Mounting heights of devices may be typically identified on drawings, but such dimensions are for general pricing only. Review exact mounting heights with Consultant prior to roughing –in, refer to Architectural drawings and comply with local governing codes and standards including building code barrier free requirements.

### 3.2 INSTALLATION OF DUCT FOR DIRECT BURIED CABLES

1. Provide ducts as required for running direct buried cables as noted. Install in accordance with applicable local governing authority codes and standards and manufacturer's recommendations and instructions. Coordinate Work with trades responsible for performing excavation and backfill Work. Confirm requirements with local authority having jurisdiction. Refer to drawings for additional requirements.
2. Support direct buried underground ducts on a well-tamped flat bed of earth, free from rocks or protrusions of any kind. Grade and slope bed to provide ducts with proper drainage. Coordinate with General Trades Contractor for provision of means to carry away drainage water. Obtain required approvals of work from local governing electrical utility and review with Consultant prior to back filling and covering. Provide pull cord in each duct run.
3. Use standard duct lengths and fittings as much as possible and practicable. When cutting is necessary, carefully taper duct ends with special field tapering machine. Make joints by means of manufacturer's standard couplings. Maintain minimum bending radius of 1 m (3.3'). Use manufacturer's solvent cement and primer, and procedures for joint fitting connections.
4. Provide sloping and drainage of ducts to prevent pooling of water within ducts. Review requirements with Consultant prior to start of Work.
5. Provide manufactured expansion joints in duct at spacing as recommended by duct manufacturer.
6. When duct has been laid, draw a steel test mandrel through each duct in presence of Consultant. Diameter of mandrel to be 13 mm (1/2") less than inside diameter of duct. Remove obstruction found in duct to satisfaction of Consultant and leave duct system completely clear. No conduit will be accepted as being ready for installation of feeders until this is done.
7. Whenever Work is suspended, protect ends of ducts by means of suitable plugs and leave such plugs in use as long as may be necessary. When duct is installed for future extension, plug end of ducts for protection.
8. Provide marking tape and marking pavers as required by local governing authorities and as reviewed with Consultant.

9. Provide one continuous length of polyethylene rope or Brantford twine in each duct indicated as spare or for future use.

### 3.3 INSTALLATION OF CONDUIT

1. Provide conduit for conductors except armoured cable and copper sheathed mineral insulated conductors, and except where duct or similar raceway materials are provided.
2. Provide conduit as follows:
  1. for interior building surface mounted conductors greater than 600 V – rigid galvanized steel;
  2. for exposed conduit outside building, for semi-exterior areas such as loading areas and within parking garage floor areas – rigid galvanized steel (rigid PVC where permitted by local codes and Owner and reviewed with Consultant);
  3. for branch circuit conductors underground inside building, and underground outside building beneath concrete, asphalt, and similar paving material-rigid PVC;
  4. for branch circuit conductors underground outside building clear of concrete, asphalt and similar paving material-flexible polyethylene plastic conduit;
  5. for exposed conduit mounted at a height of less than 1200 mm (4') in electrical, mechanical or other service areas – rigid galvanized steel;
  6. for short branch circuit connectors to motorized equipment and distribution transformers (minimum length 450 mm (18"), maximum length 600 mm (24") with 180° loop where possible) – galvanized steel flexible liquid-tight conduit;
  7. at points, where conductors cross building expansion joints – galvanized steel flexible conduit with no less than 600 mm (24") of extra curve;
  8. for branch circuit conductors in poured concrete slab – rigid PVC;
  9. for interior conduit above 50 mm (2") diameter containing distribution conductors or communication systems conductors (fire alarm, telephone etc.) (except as noted above) – EMT with separate insulated ground conductor;
  10. for corrosive environments – epoxy coated rigid steel;
  11. for conductors except as noted above or elsewhere in this Specification – EMT.
3. Run rigid conductors in rigid type conduits suitable for application. Do not use flexible conduit.
4. Secure conduit located in poured concrete work in place in a manner such that conduit will not float or move when concrete is poured. Adequately protect such conduit from damage prior to and during concrete pour, and from concrete and water penetration.
5. Review with Consultant prior to Start of Work, maximum allowable size of conduit for installation in poured concrete. Placement of reinforcing steel in structural concrete work will take precedence over placement of conduit. Spaced adequately multiple runs of conduit in poured concrete work, as reviewed with Consultant.
6. Install flexible polyethylene conduit in continuous lengths wherever possible and "snake" conduit in trench. Where joints are necessary, make same with nylon inserts and stainless-steel gear type clamps. Terminate with rigid conduit threadless connectors. Grade bed to provide proper drainage of conduits.
7. Support underground conduit on a well-tamped flat bed of earth, free from rocks or protrusions of any kind. Grade and slope bed to provide conduits and ducts with proper drainage. Coordinate with General Trades Contractor for provision of means to carry away drainage water. Obtain required approvals of work from local governing electrical utility and review with Consultant prior to back filling and covering. Provide pull cord in each duct run.
8. Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by conduit manufacturer.
9. Provide a separate ground conductor in plastic conduits.



10. Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with local governing electrical code requirements by means of galvanized pipe straps, conduit clips, ringbolt type hangers, or by other proper manufactured devices.
11. Support multiple mixed size metal conduit runs with Unistrut Ltd., Electrovert Ltd. "CANTRUSS" or Burndy Ltd. "FLEXIBLE" conduit racks spaced to suit spacing requirements of smallest conduit in group.
12. Unless otherwise noted, provide conduit fittings constructed of same materials as conduit and which are suitable in respects for application.
13. Provide proper adaptors for joining conduits of different materials.
14. Cut square and properly ream site cut conduit ends.
15. Provide conduit as sized on drawings. Size conduit not sized on drawings in accordance with local governing electrical code with consideration that sizes of branch circuit conductors indicated are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with voltage drop schedule found on drawings or at end of this section. Where conductor sizes are increased to suit voltage drop requirements, increase scheduled or specified conduit size to suit. Unless otherwise noted on drawings or required by local governing electrical code or specified elsewhere, conduit to be of minimum size 13 mm (1/2") diameter. Structured network cabling system conduit to be of minimum 19 mm (3/4") diameter, unless otherwise noted.
16. Site made bends for conduit to maintain full conduit diameter with no kinking, and conduit finishes are not flake or crack when conduit is bent.
17. Plug ends of roughed-in conduits which are exposed during construction with approved plugs.
18. Ensure that conduit systems which are left empty for future wiring are clean, clear, capped and properly identified at each termination point. Provide end bushing and suitable fish wires in such conduits.
19. Provide empty conduits to ceiling spaces from flush mounted panelboards located below and/or near hung ceiling. Refer to drawing detail.

### **3.4 INSTALLATION OF OUTLET BOXES AND BACK BOXES**

1. Provide an outlet box or back box for each luminaire, wiring device, telephone outlet, fire alarm system component, communications systems components, and each other such outlet.
2. Size boxes to accommodate exact supplied components and for bending radii of installed cables. Confirm requirements with respective system vendors.
3. Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where connecting conduit is EMT, to be stamped and galvanized steel outlet boxes unless otherwise noted.
4. Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
5. Outlet boxes in plastic conduit systems to be rigid PVC plastic outlet boxes, unless otherwise noted.
6. Outlet boxes for flush floor mounted devices to be concrete tight formed galvanized steel fully adjustable flush floor boxes. Locate in to position and install in accordance with manufacturer's instructions. Coordinate installation with trades pouring concrete floor slab or trade responsible for floor construction.
7. Provide barriered outlet box for switches connected to normal and emergency power and share a common faceplate.

8. Provide outlet boxes for special wiring devices, for special equipment and special applications. Refer to requirements specified in other Sections and/or on drawings.
9. Size and arrangement of outlet boxes to suit device which they serve.
10. Mounting heights and locations for outlet boxes are typically indicated on drawings, however confirm exact location and arrangement of outlets prior to roughing-in. Architectural drawings and Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.
11. Do not install outlet or back boxes "back-to-back" in walls and partitions. Stagger such outlets and seal against noise transmission in accordance with drawing details. "Thru-wall" type boxes will not be permitted for any application.
12. Properly support exterior mounted boxes for receptacles as noted on drawings. Where location is not adjacent a structure, provide rigid conduit support properly imbedded into ground and secure box at suitable required height. Review exact installation requirements with Consultant prior to start of work.
13. Provide blank coverplates over boxes left empty for future installation of devices. Clearly identify each box as to its intended use, to Owner's approval and reviewed with Consultant. Generally, provide stainless steel type blank coverplates.

### **3.5 INSTALLATION OF PULLBOXES AND JUNCTION BOXES**

1. Provide pullboxes in conduit systems wherever shown on drawings, and/or wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m (100") in length, or with more than two - 90° bends, are to be equipped with a pullbox installed at a convenient and suitable intermediate accessible location.
2. Size boxes to accommodate exact supplied system and for bending radii of installed cables. Confirm requirements with respective system vendors.
3. Provide junction boxes wherever required and/or indicated on drawings and as required by local governing electrical code.
4. Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
5. Boxes in rigid conduit and EMT inside building to be stamped galvanized or prime coated steel.
6. Boxes in exterior rigid conduit and boxes in perimeter wall where insulation and vapour barrier is present, to be "Condulet" cast gasketed boxes, unless otherwise noted.
7. Boxes in plastic conduit to be rigid PVC plastic boxes complete with required couplings.
8. Pullboxes and junction boxes to be accessible after work is completed.
9. Accurately locate and identify concealed pullboxes and junction boxes on "As-built" record drawings.
10. Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Paint colours to be in accordance with following schedule:
  1. lighting-yellow;
  2. normal power-blue;
  3. essential power-orange;
  4. fire alarm-red;
  5. telephone-green;
  6. miscellaneous signals-brown.
11. In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.

12. Cover boxes in fire walls with aluminium tape and seal with caulking.

### 3.6 INSTALLATION OF SLEEVES

1. Where conduits, round ducts and conductors pass through structural poured concrete, provide sleeves of type suitable for application, and approved by local governing codes.
2. Sleeves in concrete slabs, except as noted below, are to be No. 24 gauge or equivalent, with an integral flange to secure sleeves for formwork construction.
3. Sleeves in waterproof concrete slabs and in other slabs where waterproof sleeves are required are to be lengths of Schedule 40 pipe sized to extend 100 mm (4") above floor.
4. Sleeves in poured concrete walls and foundation are to be Schedule 40 pipe.
5. Size sleeves, unless otherwise noted, to leave 13 mm (1/2") clearance around conduit, duct, conductor, etc. Void between sleeves and conduit, duct, conductors, etc., to be packed and sealed for length of sleeves as in accordance with article entitled "Firestopping and Smoke Seal Materials" specified here in this Section. Pack and seal sleeves set in exterior walls with governing authority approved materials suitable for application and pack both ends of sleeves watertight with approved permanently flexible and water tight materials. Coordinate exact responsibility of work with General Trades Contractor.
6. Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work. Completely and accurately dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
7. Supply sleeves of a water protecting type in accordance with detail found on drawings for installation in following locations:
  1. in Mechanical and Fan Room floor slabs, except where on grade;
  2. in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets;
  3. in floors equipped with waterproof membranes.
8. "Gang" type sleeving to be permitted only with approval of Owner and reviewed with Consultant.
9. Terminate sleeves for work which is exposed, so that sleeve is flush at both ends with wall, partition, or slab surface such that sleeve may be covered completely by escutcheon plates.

### 3.7 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. Manufacturer's installation instructions for each specific application.
  2. Clean areas and surfaces before materials are installed.

3. Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is to be installed. Confirm compatibility of surfaces.
4. Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.
5. 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.
6. Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.
7. Prime substrates in accordance with product manufacturer's written instructions.
8. Provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing.
9. Tool or trowel exposed surfaces to a neat, smooth, and consistent finish.
10. Remove excess compound promptly as work progresses and upon completion.
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.

### **3.8 INSTALLATION OF FASTENING AND SECURING HARDWARE**

1. Provide fasteners, anchors and similar hardware required for conduit, duct, raceway, conductors, etc. and for equipment hanger and/or support material unless otherwise noted.
2. Accurately and properly set concrete inserts in concrete framework. Where multiple type inserts are used, space same to suit requirements of smallest conduit, etc., in group.
3. Fasten hanger and support provisions to masonry with expansion shields and machine bolts, or, for light loads, use plugs, and screws.
4. In drywall or plaster walls and/or ceilings use two wing toggles and for heavy loads, provide steel anchor plates with two or more toggles to spread load.
5. Provide beam clamps for attaching hanging and/or support provisions to structural steel, or where approved by Owner and reviewed with Consultant, weld hanging and support provisions to structural steel.
6. Install devices in accordance with manufacturer's instructions to suit each respective application.
7. Explosive powder actuated fasteners are not permitted unless specific approval for their use and type has been obtained from Owner and reviewed with Consultant.
8. Under no circumstances use ceiling suspension hangers or grids for suspension of conduit and conductors. Install supports to permanent structure of building, limited to areas that will not damage structural stability.
9. Install Velcro tie wraps on bundled telecommunication cables and do not over tighten. Provide FT6/CMP rated wraps in plenum type spaces as per local building code requirements.
10. Comply with Consultant's (Structural Engineer's) limitations for maximum penetrations of securing hardware into concrete slabs.

### 3.9 INSTALLATION OF IDENTIFICATION NAMEPLATES

1. For each piece of electrical distribution equipment from electrical source of supply up to and including panelboards, for special control panels and cabinets, and for each other piece of electrical equipment, provide engraved Lamacoid identification nameplates secured to apparatus with stainless steel screws. Nameplates to indicate source of electrical supply and include Consultant's equipment identification number. Identify whether equipment is on "NORMAL POWER SYSTEM" or "ESSENTIAL POWER SYSTEM", where applicable.
2. Equip large multiple cell or component apparatus such as switchboards and distribution panels with main nameplates identifying equipment, voltage characteristics, capacity and source of supply, and with sub-nameplates clearly identifying each cell or component and its service.
3. Panelboard nameplates to identify panelboard number as designated on drawings, unless otherwise instructed. Nameplates for disconnect switches, control panels, and cabinets to outline their service and source of supply.
4. In areas where equipment having removable doors that can be commonly installed on different equipment, ensure that each door is identified to which piece of equipment it is associated with, such that nameplates are with correct equipment.
5. Building wings for panelboard identifications to be reviewed with Consultant prior to start of work.
6. Building floors for panelboard identifications to be indicated as follows:
  1. "B" or "C" denotes Basement or Concourse where applicable to match installation;
  2. "G" denotes Ground Floor;
  3. 1 to 10 denotes Floors 1 through 10.
7. Panelboard types are to indicate service as follows:
  1. "DP" denotes "Distribution Panel" that feeds various branch circuit panels and larger loads;
  2. "LP" denotes "Lighting Panel" for lighting and general receptacle loads;
  3. "PP" denotes "Power Panel" for multiple loads within a specific area such as a shop;
8. Where panelboards are supplied from Emergency Power, panelboard type to be preceded by letter "E", i.e. "EDP", "ELP", "EPP", "EKP", etc.
9. Nameplates to be mechanically secured lamacoid and be colour coded as follows:
  1. Normal Power Black with white letters;
  2. Emergency Power Red with white letters;
  3. UPS Power Orange with white letters.
10. Above identification nameplate and nomenclature requirements are for typical requirements for pricing only.
11. In pull boxes, junction boxes and at terminations, identify feeders by use of plastic plates indicating system voltage and circuit designations. Plates to be 25 mm (1") in diameter and have letter stamped 9 mm (5/8") high. Colour coding to be:
  1. Phase A – red;
  2. Phase B – black;
  3. Phase C – blue;
  4. Neutral – white;
  5. Ground - green.
12. Review print size type and size, colours, sizing and nomenclature of nameplates with Consultant prior to ordering. Submit sample board.

### **3.10 INSTALLATION OF TERMINAL BACKBOARDS**

1. Provide specified terminal backboards for communication systems and electrical distribution equipment.
2. Securely wall mount each backboard with proper fasteners to suit wall construction.
3. Unless otherwise noted, size backboards to sufficiently provide adequate terminal space for each system, plus 20% space for future additions.

### **3.11 INSTALLATION OF SIGNAGE**

1. Provide signage as required.
2. Provide warning signs as applicable for following:
  1. on doors into transformer vaults;
  2. on doors into high voltage switchgear rooms;
  3. on doors to genset room;
  4. on doors into main electrical rooms;
  5. for other applications as noted.
3. Secure signs to equipment with stainless steel screws. Number of signs required and sign wording, symbols, and colours to be approved by Owner and reviewed with Consultant, and local electrical utility and other governing authorities, where applicable.

### **3.12 INSTALLATION OF ROOFTOP SUPPORT SYSTEM**

1. Install rooftop support system for conduits/raceways in accordance with manufacturer's instructions and recommendations to suit type of raceway and roofing materials.
2. If gravel top roof, remove gravel from around and under pipe support. Coordinate work with building roofing vendor confirmed with Owner and reviewed with Consultant.
3. Consult existing roofing vendor for roof membrane compression capacities and roof loading limitations. Comply with restrictions.
4. Use properly sized clamps to suit conduit sizes. Ensure that installation and use of system does not invalidate existing roof warranties.
5. Engage existing roofing vendor to inspect installation and verify that installation has not damaged roof.

### **3.13 BRANCH CIRCUIT BALANCING**

1. Connect branch lighting and power circuits to panelboards so as to balance actual loads (wattage) within 5%. If required, transpose branch circuits when work is complete to meet this requirement.
2. Perform necessary tests to show compliance with above requirement. Make such tests after building is occupied and document into testing report.

### **3.14 EQUIPMENT BASES AND SUPPORTS**

1. Provide equipment bases, supports and concrete housekeeping pads for mounting of floor standing equipment and luminaire pole bases.
2. Secure floor mounted equipment in place on 100 mm (4") high concrete housekeeping pads, 100 mm (4") wider and longer than equipment base dimensions. Chamfer edges of bases. Include for seismic restrains as required by local governing building code.
3. Supply dimensioned drawings, templates, and anchor bolts for proper setting of equipment on bases and pads. Be responsible for required levelling, alignment, and grouting of equipment.
4. Submit to Consultant for review, dimensioned shop drawings of structurally designed concrete pads or bases for support of large, heavy equipment. Indicate on shop drawings total weight of pad or base, reinforcement, and equipment for which it is required.

5. Unless otherwise noted, support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods.

### 3.15 CONCRETE WORK

1. Provide concrete required for work, including formwork and reinforcing steel.
2. Unless otherwise noted in Division 03, concrete to be minimum 20700 kPa (3000 psi) ready mix concrete provided in accordance with latest editions of CAN/CSA-A23.1 "Concrete Materials and Methods of Concrete Construction" and CAN/CSA-A23.2 "Methods of Tests for Concrete".
3. Perform work to standards and general requirements of Division 03.
4. Comply with local governing authority and local standard practices in providing concrete to compensate for local frost level of Place of Work.

### 3.16 EXCAVATION AND BACKFILL

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 that 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. Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Be responsible for confirming that inverts and locations are correct, prior to commencing excavation. Where discrepancies are found, immediately inform Consultant, and await a direction.
4. Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.
5. Provide excavation, backfill, and related work required for work. Obtain a copy of soil test report if available from Owner or Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of Work.
6. Grade bottom of excavation. In firm, undisturbed soil, lay services directly on soil. Backfill excess excavation with 13,790 kPa (2,000 psi) concrete. Grade bottom such that ducts are installed to drain as reviewed with Consultant.
7. Prepare new bedding under service in unstable soil, in fill, and in cases where bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, and at manholes and catch basins, compact to maximum possible density and support service by means of 200 mm (8") thick concrete cradles spanning full length between firm supports. Refer to detail on drawings.
8. Where excavation is necessary in proximity to and below level of any footing, backfill with 13,790 kPa (2,000 psi) concrete to level of highest adjacent footing. Proximity is determined by angle of repose as reviewed with Consultant.
9. Do not open trenches ahead of installation of services and backfilling more than weather permits. Break up rocks and boulders and remove by drilling and wedging. Do not use blasting unless specifically permitted by Owner and reviewed with Consultant.
10. 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. Remove shoring during backfilling.

11. 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 compacted level of 300 mm (12") above top of service. Hand or machine compact balance up to grade using approved equipment.
12. Backfill trenches outside building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") above service with Granular "A" material, hand compacted to a density of 95% Standard Proctor. Backfill balance with 150 mm (6") layers of approved excavated material compacted to 95% Standard Proctor density, using approved equipment.
13. Backfill trenches outside building under roads, parking lots or traffic areas with granular "A" material in layers not exceeding 150 mm (6") thickness, compacted to 100% Proctor density up to grade level.
14. 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. Generally, final surface toppings are responsibility of another Division of Work. Coordinate exact requirements with General Contractor to ensure surface toppings are provided as required to match adjacent surfaces.
15. 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 that minimum damage or disfigurement of ground and which in no causes way impedes progress of work;
  2. separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.
16. Provide pumping equipment as required to keep excavations free of water.
17. Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.

### **3.17 FINISH PAINTING OF ELECTRICAL WORK**

1. Unless otherwise noted, finish painting of exposed Electrical Divisions work is to be performed as part of work of Division 09.
2. Provide identification painting for electrical distribution equipment in accordance with application requirements of Division 09. Review exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:
  1. pull boxes and junction boxes;
  2. communication system conduit;
  3. genset exhaust piping.
3. Spray painting is not permitted unless approved in writing by Owner and reviewed with Consultant.

### **3.18 PROVISIONS FOR FURNITURE SYSTEMS**

1. Ensure that rough-in for electrical devices including but not limited to outlets, switches, thermostats, control devices, fire alarm devices and clocks and communications devices are located to avoid wall mounted systems furniture wall strips. Relocate conduit and devices which do not coordinate with systems furniture requirements identified on systems furniture drawings.
2. Coordinate location of electrical conduits/ducts within floor slabs and mounted to underside of floor slabs, with location of free-standing work stations and furniture systems.



3. Coordinate connection of electrical and communication devices with systems furniture supplier. Generally, supply and installation of power, data and communication wiring and devices are by Electrical Division. Furniture system connection "whips" to be supplied by furniture system vendor and turned over to Electrical Division for installation. Confirm responsibility of supply of whip with General Trades Contractor. Power conductors are to be installed to a wall/ceiling mounted junction box and extended out to furniture system, through empty conduit, raceways, and back boxes provided within furniture system. Branch circuit conductors in furniture system raceways may be AC-90 flexible armoured conductors. Telecommunication (data/voice) conductors are to be complete home runs from LAN closet to work station outlet. Testing and verification of furniture system devices is responsibility Electrical Division. Confirm exact requirements with furniture system trades. Where furniture systems are not supplied with pre-wired devices, be responsible for supply, installation and wiring of required devices.

### 3.19 CONDUIT PROVISIONS FOR MISCELLANEOUS SYSTEMS

1. Provide following components to accommodate future installation of various miscellaneous systems by system installers who are to provide equipment and wiring:
  1. conduit - diameters as sized on drawings with non-metallic fish wires or pull cords and suitable bushings for conduit terminations, and as specified in Part 2; provide labelling at each end to clearly identify each conduit run with respect to system and path;
  2. outlet boxes - standard galvanized steel, each complete with a blank type faceplate, and as specified in Part 2;
  3. pull boxes, junction boxes, back boxes and sleeves - and as specified in Part 2.
2. Miscellaneous systems are typically as shown on drawings. Unless otherwise noted on drawings, provide dedicated conduit runs for each system. Coordinate sizes of boxes with respective system vendors to ensure proper sizing to accommodate components and that allows for wiring bending radii. Confirm conduit and box requirements also with system vendors.
3. Provide pullboxes in conduit runs longer than 30 m (100') or having more than two -90 bends. Size pullboxes to be at least 8 times entering conduit in length. Pullbox sizes to comply with respective system standards.
4. Leave conduits free and clear of all obstructions and terminate as required. Equip terminations with bushing, and clearly identify each run. Provide fish wires in all empty conduits. Run telecommunications conduits to comply with separation from sources of electromagnetic radiation as per standard ANSI/TIA/EIA-569. Site bend telecommunications conduit elbows to comply with system conduit bending radii requirements.
5. Review exact requirements and locations of equipment with Consultant and respective system installers prior to roughing-in.
6. Refer to system riser diagrams on drawings.
7. Quantities for outlets to be as per floor plan drawings and not riser diagrams.

### 3.20 DOOR HARDWARE

1. Generally, Division 08 or another Division not under scope of Electrical Contractor, is responsible for supply and installation of door alarm contacts, door holders, electric strikes, electromagnetic locks, door operator controls, power supplies, door controllers, central electromagnetic lock release controller and other door hardware. Coordinate and confirm with General Trades Contractor and respective equipment vendors (door hardware / security) exact responsibility of each Division of the Work.
2. Confirm product and wiring requirements, back box requirements and wiring installation requirements with door hardware trades and with equipment vendors. Provide required wiring in conduit from each device to respective controllers, between each device, and to central control panel and for power connection to such controls and devices. Provide line level voltage power feeds to equipment as required.

3. For controls and interconnections between devices, when such device terminations are responsibility of others, supply and run interconnecting wiring in conduit to devices and allow spare length of 1.8 m (6') coiled wiring at each end for final termination to devices by others.
4. For applications of electro- magnetically held closed doors, engage fire alarm system vendor to provide fire alarm type pull station with auxiliary contacts as required for interconnection of electro- magnetic door hardware and fire alarm system for release of doors. Provide required wiring in conduit and connections. Coordinate pull station requirements with fire alarm system vendor.
5. Exact type of door alarm contacts to be coordinated with door construction and finishes. Contacts to generally be recessed mounted and wiring be installed in concealed conduits. Confirm exact requirements with door hardware/security vendor and General Trades Contractor.
6. Where controls are located remotely from door locations, such as in closets, provide wiring in conduit and extend from local above door junction boxes and devices as required with homeruns back to closet location of equipment and leave slack wiring for terminations by others. Confirm exact requirements with door hardware / security vendor and General Trades Contractor.
7. Drawing details issued with electrical drawings are for pricing reference only and are based on assumptions. Obtain detailed design drawings from successful door hardware / security vendors and provide wiring in conduit to coordinate with and accommodate final systems designs. Coordinate with General Contractor.
8. Submit as part of shop drawing submission, detailed responsibility matrix identifying work and responsibilities of each trade and required interconnections.
9. After installation is complete, test and verify operation of components in coordination with General Contractor and door hardware vendor.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products and accessories.
2. Submit samples of conductors, where requested in Contract Documents or when requested by Consultant.

## 2 Products

### 2.1 GENERAL POWER CABLES

1. CSA approved, ULC labelled and certified. Unless otherwise noted, conductors to be copper and be suitable for applications as noted in governing local electrical code.
2. "RW90" CSA certified, single copper conductor to CSA C22.2 No. 38, 600 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, X-link polyethylene (XLPE) insulation, colour coded.
3. "T90 Nylon", CSA certified, single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 90°C (194°F) dry conductor temperature, -10°C (-14°F) minimum installation temperature, PVC insulated, nylon covered.
4. "TWU" single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 60°C (140°F) conductor temperature, -40°C (-40°F) minimum installation temperature, PVC insulated suitable for wet and buried installations, colour coded.
5. "RWU90" CSA certified, single copper conductor to CSA C22.2 No. 38, 1000 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, extra thickness X-link polyethylene (XLPE) insulation suitable for wet and buried installations, colour coded.
6. Nexan DriveRX type cable for variable frequency drives: CSA approved to C22.2 no 123; flame, oil and UV resistant cable with copper conductors, corrugated continuous aluminum sheath and 3 bonding conductors; impact and crush resistant; temperature rating is 90°C to -40°C; 1000V 90C rated cross link polyethylene insulation; FT4 PVC jacket;
7. Solid conductors to and including No. 10 AWG; stranded conductors in sizes larger than No. 10 AWG; branch circuit conductors constructed of 98% conductive copper; and approved for minimum 600 volts, with minimum 1000 volts where noted.

### 2.2 CONNECTORS

1. General:
  1. materials: CSA approved and/or ULC listed and labelled as required by local governing authorities and codes;
  2. certification: CSA C22.2 No. 65;
  3. connectors marked with certification, manufacturer, manufacturer catalogue number and approval for conductor size and type.
2. Armoured cable connectors of proper squeeze type connectors and plastic anti-short bushings at terminations.
3. Connectors for conductors connecting to devices in accordance with local governing electrical requirements, equal to Ideal Industries No. 451, No. 452 and No. 453, "Wing-Nut", CSA certified, 600 volts rated, contoured wing design, fire retardant shell, twist on pressure type connectors.
4. For conductors sized 3/0 and greater, provide long barrel double crimp, 2-hole compression type lug connectors, unless otherwise noted.

### 2.3 FIRE RATED CABLES

1. nVent - Pyrotenax, model "System 1850", CSA certified, ULC listed and labelled, FM Specifications tested, 600 V, type "MI", 2-hour fire rated, copper sheathed, copper conductor, highly compressed magnesium oxide mineral insulated power cable. Connectors for copper-sheathed mineral conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications. Certified to C22.2 No. 124 and ULC Listed 2-hour fire-resistive cable tested to ULC-S139 fire test standards.
2. nVent Pyrotenax, model "System 1850 Twisted Pair", CSA certified as FAS, FAS 90 and FAS 105 cable, ULC listed and labelled, 300 V, type "MI", 2-hour fire rated, copper sheathed, copper conductor, highly compressed magnesium oxide mineral insulated fire alarm and voice communication cable. Connectors for copper-sheathed mineral conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications. ULC Listed 2-hour fire-resistive cable tested to ULC-S139 fire test standards.
3. Manufacturer's termination kits: Pyropak epoxy sealing compound kits and "Quick Term" connectors; connectors for MI conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications.
4. Unistrut type C-channel supports, cable clips and straps as recommended by cable manufacturer to suit specific installation application. In applications of dissimilar materials, provide tape to insulate cabling and hardware.
5. Brass plates for cable openings in ferrous metal enclosures.
6. Include for required cable manufacturer's accessories and identification labelling.
7. Include for manufacturer's authorized technician to perform initial coordination with and providing training to installing personnel on review of proper installation of cabling runs and termination of cabling. After completion of Work, manufacturer's technician to review installation work, test cabling and terminations and provide formal report of test results with observations, certification that installation work is complete and cabling with terminations perform as required, to satisfaction of cable manufacturer.
8. Acceptable manufacturer of fire rated MI type cables is nVent.

### 2.4 CONDUCTOR PULLING LUBRICANT

1. IDI Electric, "Ideal Yellow 77" or "Wire Lube" as required.

### 2.5 TRACER WIRE

1. Tracer wire, also called locator wire, to be provided to assist in locating ducts, conduits, pipes and other lines after they have been buried underground.
2. Standards:
  1. ULC listed and labelled.
  2. ASTM.
  3. ICEA/NEMA.
  4. Direct burial rated.
3. Standard Tracer Wire: solid copper conductor insulated with high molecular weight polyethylene (HMWPE); manufactured according to ULC constructions in both 30 V and 600 V versions suitable for use at maximum continuous operating temperature of 75°C (167°F) in wet and dry locations.
4. Tracer wire to be compatible for use and connection to industry standard frequency generator which is connected directly to cable to be traced, and high or low frequency signal is applied. In passive method, power voltages are sometimes applied at frequency of 50-60 Hz.

5. Connectors to be moisture displacement connectors as recommended by wire manufacturer to suit applications. Connectors equivalent to Copperhead SnakeBite or 3M DBR series.
6. Typically, size no.14 AWG for installation in open trench; no. 2 AWG typically in conjunction with trenching machine; for directional boring applications, minimum no.10 AWG. Comply with manufacturer's recommendations.
7. Jacket colour: unless otherwise required by local governing authority or code, or by Owner, and reviewed with Consultant, provide jacket colour for applications as follows:
  1. Electrical - red;
  2. Gas - yellow;
  3. Communication - orange;
  4. Potable Water - blue;
  5. Sewer - green.
8. Include for after installation inspection and testing. Refer to Part 3 for additional requirements.

### 3 Execution

#### 3.1 PROJECT CONDITIONS

1. If identified in documents, verify that field measurements and conditions are as identified.
2. Unless specifically noted, cable routing on drawings is schematic and approximate and not reflective of elevations. Route cable as required to meet project conditions. Determine exact routing and lengths on site.
3. Confirm fire protection ratings of construction to ensure that rooms and paths of conductors are fire rated in accordance with local governing codes requirements. Include fire rated conductors as required to meet local governing codes requirements.

#### 3.2 CO-ORDINATION

1. Co-ordinate work with work provided under other electrical work and work of other trades.
2. Determine required separation between cable and other work.
3. Determine cable routing to avoid interference with other work.
4. Submit any alternative cable routing to Consultant for review prior to proceeding with work.

#### 3.3 INSTALLATION OF CONDUCTORS

1. Provide required conductors. Provide fire rated conductors for applications as required by local governing codes and standards, and requirements of local governing authorities.
2. In applications where, multiple conductors in conduit are being run, provide trapeze configuration of Unistrut type metal C-channels and threaded rod hangers to support cable/conduit from ceiling slab. Wall mounted cable/conduit brackets and ring type conduit hangers may be permitted in applications approved by Owner and reviewed with Consultant. Provide required cable support system accessories which are not specified herein or shown on drawings but are required for proper installation.
3. Conductors, unless otherwise noted, to be as follows:
  1. underground inside or outside building and for non-climate-controlled areas - "TWU" or "RWU90";
  2. for connections to electric heating coils in supply air ductwork systems, and for connections to other electric heating equipment where use of 90 degrees C. rated conductors are recommended by heating equipment manufacturer - "RW90";

3. for conductors requiring fire rating by current regulations and local codes including feeders for emergency systems, fire fighter's elevators, fire alarm systems, other life safety systems and for applicable signal and control circuits of these systems - type "MI" CSA approved, ULC listed and labelled, 2-hour fire rated, copper sheathed mineral insulated copper conductors;
4. for connections to variable speed drives: Nexan DriveRX type cable for variable frequency drives as recommended by drive manufacturers;
5. for climate-controlled areas wiring except as noted above or specified elsewhere in Specification or as noted on drawings - "T90 Nylon" or "RW90".
4. Install control wiring as required and as indicated. Confirm exact type of control wiring with manufacturers of equipment/systems being interconnected, and as required by local governing electrical code. Provide required fire alarm cables for fire alarm system applications or security system applications as recommended by fire alarm system manufacturer, complying with requirements of local governing code and local governing authorities. Typically run control wiring in conduit. Conductors not installed in conduit or raceways to be fire insulated rated in accordance with latest governing code flame spread ratings requirements, and suitably mechanically protected by means acceptable to Owner and reviewed with Consultant. Ensure that conductors comply with fire rating - FT6 rating requirements when run in plenums and similar construction.
5. Coordinate responsibility for provision of control wiring for Mechanical Division equipment and equipment of other Divisions, with respective Divisions of the Work.
6. Generally, conductor sizes are indicated on drawings. Such sizes are minimum requirements and must be increased, where required, to suit length of run and voltage drop in accordance with applicable conductor voltage drop schedule on drawings or obtained from Consultant. Conductors not sized or specified of type, to be sized and of type in accordance with requirements of local governing electrical code.
7. Do not use conductors smaller than No. 12 AWG in systems over 30 volts, unless otherwise noted. Do not use conductors smaller than No. 6 AWG for exterior luminaire wiring unless otherwise noted.
8. Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours, unless otherwise noted, to be as follows:
  1. Phase A - red;
  2. Phase B - black;
  3. Phase C - blue;
  4. Ground - green;
  5. Neutral - white;
  6. Control - orange.
9. When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraded.
10. Control conductors, in addition, to be numbered with Brady Ltd. or Electrovert Ltd. Z type markers.
11. Colour code conductors for communications systems in accordance with system component manufacturer's recommendations.
12. Neatly secure exposed wire in apparatus enclosures with approved supports or ties.
13. Install low voltage conductors in conduits, unless otherwise noted within Documents.

### 3.4 INSTALLATION OF FIRE RATED CONDUCTORS

1. Obtain from local governing electrical authority, approval of proposed fire rated cable to be installed.
2. Obtain installation and testing training from cable manufacturer as required for specific cabling type. Installation to be performed by personnel experienced in installation of specific cabling.
3. Submit with shop drawings, copy of manufacturer's detailed installation manual and testing procedures. Provide 2-hour fire rated type, CSA approved, ULC listed and labelled, copper conductors for following:
  1. conductors to elevators;
  2. conductors to fire pumps and sprinkler pumps;
  3. conductors to smoke venting fans;
  4. conductors to emergency lighting panel boards;
  5. conductors to fire alarm control panels and transponders;
  6. fire alarm conductors risers;
  7. conductors as required by Code requirements;
  8. fire alarm system feeders as shown interconnecting existing fire alarm system and additional system;
  9. applicable local governing code required applications for control and signalling conductor circuits of and between life safety equipment and systems;
  10. conductors as noted on drawings.
4. Provide fire rated type cabling for specific conductors as noted and as required for specific applications by local governing codes. Install fire rated type conductors for applications noted above and as shown on drawings in strict accordance with the manufacturer's instructions and recommendations. Installation must be in a neat and professional manner as per manufacturer's approval. Make arrangements for manufacturer's technician to provide onsite services as specified. Conductors not sized on drawings, to be sized in accordance with requirements of local electrical code.
5. Provide Unistrut C-channels, clips, wall brackets, etc., as required and as recommended by cable manufacturer to suit the on-site installation conditions. Provide system of Unistrut type C-channel hangers and rods spaced at minimum 1.2 m (4') but which must be confirmed with cable manufacturer, for running of cables. Where clips and other hardware are in contact with cables, insulate cables/hardware with suitable tape as per cable manufacturer's recommendations for applications of dissimilar metals.
6. Make terminations of conductors with manufacturer's approved components and connectors in accordance with manufacturer's recommendations. Obtain proper tools for cable terminals from the cable manufacturer. Terminations must be completed immediately once started to avoid moisture ingress from the surrounding air. Connections to ferrous cabinets for single conductor cables shall incorporate brass plates sized as required and as per cable manufacturer's requirements. Brass plates shall be complete with required drilled and tapped holes. Cable lugs to be temperature rated as per manufacturer's instructions.
7. Splicing of cables is not permitted.
8. When pulling cable, apply pulling tension to the conductor not in sheath of cable. Limit cable pulling tension to as recommended by cable manufacturer.
9. Terminate cable in equipment with termination kits as per cable manufacturer's instructions.
10. Terminations to be witnessed by manufacturers authorized technician. Perform terminations in accordance with cable manufacturer's instructions.
11. Terminate cables to transformers, motors and other vibrating equipment by use of means to isolate vibration in accordance with cable manufacturer's recommendations.

12. Ground cabling as per cable manufacturer's instructions and as per local governing electrical code requirements.
13. Take necessary precautions when handling cable on reel to ensure that no damage will result in the uncoiling process.
14. Where cables penetrate fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect integrity of fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide tray type suitable for plenum environments.
15. Engage with cable manufacturer to test cables and terminations after installation, in strict accordance with cable manufacturer's recommendations. Megger terminations to check that insulation resistance is acceptable to cable manufacturer. Prior to completing each termination, test insulation resistance and follow cable manufacturer's procedures until resistance reaches cable manufacturer's listed acceptable level.
16. Include and arrange for cable manufacturer's authorized representative to review installation and associated work and testing of installed cables. Prepare report consisting of test sheets with results of cables tested and a certificate of verification signed by testing engineer/technician. Report to include copy of cable manufacturer's signed inspection letter validating test results and documenting that work was performed to satisfaction of manufacturer. Submit minimum one hard copy and electronic copy to Consultant.

### **3.5 INSTALLATION OF TRACER WIRE**

1. Install tracer wire in accordance with wire manufacturer's recommendations for specific applications.
2. Connect with proper connectors to protect from moisture and corrosion. Do not twist wires together and wrap with electrical tape.
3. Place tracer wire in same orientation to installed pipe. Using spacer, tape tracer wire to pipe every 2.4 m to 3 m (8 to 10 feet) in three o'clock position or provide fill between pipe and tracer wire. Install colour coded warning tape minimum 300 mm (1') above pipe.
4. Bring tracer wire above ground for ease of terminating signal and terminate in test station.
5. Ground ends of wire.
6. After installation is complete, perform conductivity test or locate test and demonstrate to Consultant and Owner.

**END OF SECTION**



## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products and accessories.

## 2 Products

### 2.1 BASIC MATERIALS

1. General:
  1. Materials: CSA approved and/or ULC listed and labelled as required by local governing authorities and codes.
  2. Certification: CSA C22.2 No. 41.
  3. connectors marked with certification, manufacturer, manufacturer catalogue number and approval for conductor size and type.
2. Ground Rods: Copper-clad steel, 20 mm (3/4") diameter circular cross-sectionalized, with driving cap and bronze tip, overall length of 3 m (10') long.
3. Ground Conductors: Solid copper, insulated and bare to suit application and code requirements; and bond conductors.
4. Ground Busbar: Solid copper busbar, predrilled for two-hole lug connections, of size of 50 mm x 9 mm x 900 mm (2" x 3/8" x 36"), for wall and backboard mounting using standoff insulators.
5. Ground Connections:
  1. Below Grade: Exothermic-welded type connectors, made by exothermic welding process of joining similar metals using high temperature reaction of powdered copper oxide and aluminum.
  2. Above grade or in manholes or hand holes: Compression type copper connectors of type to suit intended applications.
  3. Within substations and vaults: Compression type copper connectors of type to suit intended applications, and in accordance with IEEE 837.
  4. Exothermic connections permitted above grade when approved by Owner and reviewed with Consultant.
  5. When making ground and bonding connections, apply corrosion inhibitor to contact surfaces. Use corrosion inhibitor appropriate for protecting connection between metals used.
6. Ground Pit: Flush in grade grounding pits with following features:
  1. removable cast concrete cover with recessed lifting handle;
  2. cast iron or precast concrete pit;
  3. ground rod, ground clamps and grounding conductors as required;
  4. clay sewer tile for proper drainage.
7. Gravel/Stones: Provide gravel and crushed stones as required by local governing authorities to suit application. Layers to be of thickness not less than required by local governing authorities.
8. Miscellaneous ancillary components to complete grounding and bonding work to requirements of local governing electrical authority and codes.
9. Acceptable Manufacturers:
  1. Exothermic Process:
    1. Cadweld (nVent - Erico).
    2. BURNDYWeld (Hubbell).
  2. Compression Connectors, Ground Rods, Bus Bars, Fittings and Ancillary Products:
    1. Hubbell – Burndy.

2. nVent – Erico.
3. ABB – T&B.
4. ILSCO.

### 3 Execution

#### 3.1 GENERAL GROUNDING AND BONDING REQUIREMENTS

1. Provide required grounding and bonding work in accordance with drawings, local governing electrical authority, governing authorities having jurisdiction and local governing electrical inspection authority. Provide local governing electrical utility's grounding requirements for stations, vaults and electrical rooms, as applicable. Confirm requirements with local governing electrical utility. Comply with requirements of local governing electrical codes.
2. Provide 50 mm x 9 mm x 900 mm (2" x 3/8" x 36") electrical grade copper ground bus on perimeter wall of electrical rooms, 300 mm (12") above finished floor level. Secure ground bus on 20 mm (3/4") standoff insulators. Connect electrical rooms ground grid with ground bus with minimum 3/0 copper ground conductor in conduit. Connect each electrical room perimeter ground electrode system back to main electrical room ground electrode with minimum No. 3/0 copper conductors.
3. Ground and bond other equipment such as transformers, switchboards, panelboards, and similar metal work to perimeter ground bus. Provide minimum No. 3/0 insulated ground wire from ground bus in electrical rooms to switchboards, transformers, structure, floor, etc.
4. Extend conductors to metal piping of main water service and connect ground conductor to street side of water meter. If piping is not metallic, make necessary connections as required by local governing electrical utility.
5. Effectively bond metallic pipe services such as, gas mains, water mains, and dry risers, to main grounding terminal at their point of entry. Make connections to services with purpose-made grounding clamps.
6. When buses are in place, bolts have been tightened, and lugs have been installed, coat entire installation with two 100% covering coats of suitable shellac to prevent bus from oxidizing.
7. Throughout complex, solidly ground systems and make required grounding connections to electrical devices and apparatus. Ground conductors to be insulated copper wire connected with approved fittings in accordance with local governing electrical code.
8. Effectively bond building structures to main grounding system (grid).
9. Provide separate insulated ground wire for each isolated ground receptacle.
10. Extend isolated grounding conductors of computer receptacles to isolated ground bus of computer panel board serving area. From ground bus extend ground conductors to building grounding station.
11. In areas of raised floor systems, provide copper ground system as sized and detailed on drawings, and provide in compliance with local governing electrical code requirements. Bond ground system to raised floor supports and floor structure using ground clamps suitable for application, and connect system to building ground system with grounding conductors run in conduit. Bond metallic conduit which penetrates raised floor to raised floor stringer system. Install clamps and other accessories as per manufacturer's recommendations and instructions.
12. Connect grounding conductors to motors 10 hp and above or circuits 20A or above, with a solderless terminal and a bolt tapped to motor frame or equipment housing. Connect to smaller motors or equipment by fastening terminal to a connection box. Connect junction boxes to equipment grounding system with grounding clips mounted directly on box or with machine screws. Completely remove paint, dirt, or other surface coverings at grounding conductor connection points so good metal-to-metal contact is made.

13. Ground metal sheathing and exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Bond rooftop equipment.
14. Bond metal work associated with pools such as reinforcing steel, piping, ladders and ancillary devices, above ground loops by copper conductors in accordance with local governing electrical code. Clean water pump prior to bond being using approved clamps. As required, make several bonds at various locations or collect wires and make one bond. Ground electrical equipment associated with these piping systems, adequately by installing flexible conduit and ground jumper wire to motors. Ground telephone boxes, speakers, pull stations and other such equipment within pool area with jumper wires within connecting conduit to ensure proper grounding. Include for ground connections to pool reinforcing steel.
15. Provide separate ground connection for bathtubs.
16. Provide service conductors exceeding 400 amperes with minimum No. 3/0 AWG grounding conductors, unless otherwise noted.
17. Ground and bond various telecommunications, audio visual systems, security, life safety and control systems in accordance with respective system manufacturers' recommendations and in accordance with local governing electrical code requirements.
18. Make ground connections in slab or buried underground, or for joining dissimilar metals, using exothermic welding type copper connections. Install in accordance with manufacturer instructions.
19. Make exposed ground connections using compression connectors and other grounding fittings suitable for applications. Install in accordance with manufacturer instructions.
20. Provide minimum no. 3/0 AWG insulated copper ground conductors and LAN Room copper ground bus mounted on walls with standoff insulators in each LAN room. Connect ground bus to computer equipment racks and to building ground system.
21. Ground conductors not sized on drawings are to be sized in accordance with local governing electrical authority requirements. Ground conductor size is to be no smaller than requirements specified herein this article or on drawings.

**END OF SECTION**

## **1 General**

### **1.1 SUBMITTALS**

1. Submit shop drawings for products specified in this Section.

## **2 Products**

### **2.1 DUCT FOR CONCRETE ENCASEMENT**

1. DB/2 PVC, CSA Certified, tested to CSA Standard C22.2 No. 211.1.
2. Conduit to be suitable for concrete encasement and in accordance with applicable local electrical utility requirements.
3. Synthetic polypropylene fibre (plastic) twine cord or 19 mm (3/4") diameter polyethylene rope, approved by local governing Utility.

### **2.2 TRANSFORMER PAD**

1. Precast concrete transformer pad, as required to accommodate utility's transformer and generally as follows:
  1. consisting of precast concrete top cover and foundation;
  2. sized as per transformer requirements and as per local governing electrical Utility details;
  3. concrete of minimum strength of 32 MPa (4600 psi) which shall be confirmed with transformer manufacturer;
  4. steel reinforced;
  5. lifting holes;
  6. top cover openings coordinated with final design of transformer as approved by local governing electrical Utility;
  7. foundation cable openings coordinated with duct bank entry;
  8. duct drainage to suit designed sloping of ducts;
  9. suitable drainage provisions consisting of sump pit, or duct opening in bottom for connection of drainage ducts, as indicated and as reviewed with Consultant.
2. Confirm and coordinate exact requirements with transformer requirements and local governing electrical utility.
3. Acceptable manufacturers subject to approval by local governing electrical utility:
  1. Armtec Ltd (Brooklin Concrete);
  2. Industrial Cast Stone Ltd.;
  3. Utility Structures Inc.;
  4. Hanson Pipe and Pre-cast.

### **2.3 IN GROUND HANDHOLES AND PULL BOXES**

1. Fully weatherproof, watertight and corrosion resistant types for splices, pulls and junction applications:
  1. Cast-in-place concrete.
  2. Pre-cast concrete.
  3. Pre-fabricated made of semi-concrete or non-concrete materials polymer concrete.
2. CSA approved and in accordance with following, as applicable:
  1. OPSS 602;
  2. ASTM C857;
  3. ANSI/SCTE 77;
  4. Local governing authority requirements.

3. Concrete to be in accordance with CSA A23.1 and CSA A23.2. Minimum compressive strength to be of 32 MPa (4600 psi), 6-8% air entrainment, and be suitable for installation and use through a temperature range of minus 40°C to 70°C. (-40°F to 158°F).
4. Polymer concrete to consist of aggregates in combination with polymer resin, and reinforced with fibreglass. Non-conductive and non-flammable. Stable under freeze / thaw conditions.
5. Include required drainage provisions consisting of sump pit or duct opening in bottom for connection to drainage ducts, as indicated and as reviewed with Consultant.
6. Enclosures to be designed and installed to withstand loads likely to be imposed and be of size, with wiring/duct entries, covers and bottoms (as noted) and of type to suit specific applications.
7. Steel Covers:
  1. Galvanized steel according to CAN/CSA-G40.20/G40.21 and CAN/CSA-G164M92.
  2. Checker tread on top side for skid resistance.
  3. Tamper-proof, stainless steel head bolts recessed into cover.
  4. Area for logo.
  5. Flush mounted with gaskets to prevent ingress of water.
  6. No protrusions extending out from top of cover; no tripping hazards.
  7. Minimum thickness of cover is 10 mm (3/8").
8. Cable termination hardware to accommodate cables and required grounding hardware. Hardware to be corrosion resistant and in accordance with code requirements.
9. Provide PVC seals on cable entry openings.
10. Identification:
  1. Identification engraving / warning signage, weather and corrosion resistant.
  2. Identification markings on each box embedded on outside vertical surface of box, showing manufacturer's name or trademark, and date of manufacture.
  3. Top surface of cover permanently marked, showing manufacturer's name or trademark, and date of manufacture; this marking embedded into top surface of cover, or embedded into a corrosion-resistant metal plate securely cemented to top surface of cover.
11. Refer to drawings for dimensions.
12. Acceptable manufacturers are:
  1. Armtec Ltd (Brooklin Concrete);
  2. Industrial Cast Stone Ltd.;
  3. Utility Structures Inc.;
  4. Hanson Pipe and Pre-cast;
  5. Hubbell.

## 2.4 MANHOLES

1. Manholes to be provided for concrete encased ductbank runs. Provide manholes complete with cast iron covers and collars/frames, ladders, cable pulling eyes, cable management trays, etc. Sizing and locations to suit design requirements and applications. Work to comply with local governing electrical utility requirements, specifications, and details on drawings.
2. Comply with CSA/CAN A23.1 and 23.4 requirements and other required CSA Standards.
3. Precast or cast in place concrete manholes to generally be as follows:
  1. sized as per drawing detail;
  2. concrete of minimum strength of 32 MPa (4600 psi) at 28 days (6-8%) which is to suit specific applications and code requirements;
  3. steel reinforced;
  4. cable openings coordinated with duct bank entry.

4. Provide accessories as follows:
  1. minimum 800 mm (32") diameter, minimum 10 mm (3/8") thick, flush mounted cast iron cover with warning text on cover; review nomenclature with Consultant prior to ordering; covers to have no protrusions from top that may be tripping hazard; covers to have skid resistant surface; covers to include tamper proof corrosion resistant cover bolts with suitable lifting provisions;
  2. minimum 150 mm (6") thick cast iron frame;
  3. concrete levelling collars;
  4. aluminum access ladders;
  5. galvanized steel cable pulling eye loops;
  6. galvanized steel cable racks and trays;
  7. structural lifting hooks on pre-cast units;
  8. drainage: storm sewer connection with cast iron service saddle with oil resistant gasket, stainless steel clamp and oil resistant O ring;
5. Exact drainage requirements to be as coordinated with General Contractor and/or Mechanical Contractor to suit project design requirements and onsite provisions.
6. Acceptable Manufacturers:
  1. Armtec Ltd (Brooklin Concrete).
  2. Industrial Cast Stone Ltd.
  3. Utility Structures Inc.
  4. Hanson Pipe and Pre-cast.

### 3 Execution

#### 3.1 INSTALLATION OF DUCT FOR CONCRETE ENCASED DUCTBANK

1. Provide ducts and concrete encasement shown and as required, in accordance with applicable local governing authority codes and standards. Coordinate Work with trades responsible for performing excavation, backfill, and concrete Work. Confirm requirements with local authority having jurisdiction. Refer to Section entitled Basic Electrical Materials and Methods for excavation, concrete, and backfilling work requirements.
2. Use standard duct lengths and fittings as much as possible and practicable. When cutting is necessary, carefully taper duct ends with special field tapering machine. Make joints by means of standard couplings. Maintain minimum bending radius of 1 m (3.3').
3. Make concrete encased duct joints with use of couplings which provide a smooth water tight joint between ducts, using suitable cement that is specifically designed for use with duct pipe being used.
4. Separate ducts by means of plastic 75 mm (3") spacers and placed 75 mm (3") away from wooden forms on both sides ensuring that there is 75 mm (3") of concrete between ducts and a 75 mm (3") concrete envelope around duct assembly. Elevations and slopes of ducts to be as shown on drawings and as required, or based on minimum 760 mm (30") below finished grade and minimum 1% slope. Separate ducts with spacers at distance as required by local authority and as per duct manufacturers' instructions. Do not locate spacers of vertical rows of ducts directly above each other. Maintain minimum 150 mm (6") separation. Where ducts cross roads, paved areas, disturbed ground, new or future, concrete envelope to have 15 mm (5/8") diameter reinforcing steel bars laid longitudinally along trench with 100 mm (4") lateral spacing and 50 mm (2") above base of concrete. Provide an overlap of 600 mm (2') on reinforcing bars, where necessary. Extend reinforcing 1.5 m (5') beyond backfilled areas, driveways, roadways etc. Reinforce duct runs at all building entries for a distance of 1.5 m (5') out from such entry walls, bars being embedded in walls.

5. Do not place concrete around ducts, and do not backfill until duct line is inspected and reviewed with Consultant and local governing authority. If concrete is poured around ducts or if trenches are backfilled before ducts have been reviewed, be responsible for removing and replacing concrete at no extra cost to allow for approval inspections.
6. When conduit has been laid and duct banks work completed and set, draw a steel test mandrel through each duct in presence of Consultant. Diameter of mandrel to be 13 mm (1/2") less than inside diameter of duct. Remove obstruction found in duct to satisfaction of Consultant, and leave duct system completely clear. No conduit will be accepted as being ready for installation of feeders until this is done.
7. Whenever Work is suspended, protect ends of ducts by means of suitable plugs and leave such plugs in use as long as may be necessary. When conduit is installed for future extension, plug ducts and end of duct bank boxes for protection.
8. Do not lay defective ducts under any circumstances.
9. Include for provision of following requirements:
  1. concrete used for encasing ducts to have a minimum compressive strength of 20.7 mPa (3000 psi);
  2. compact and cover bottom of trench with a freshly poured concrete bed 75 mm (3") thick, for full width of trench;
  3. lay lowest row of ducts on concrete bed, completely enclosed in concrete; install subsequent layers in a similar manner; space ducts 150 mm (6") centre to centre both vertically and horizontally; fill spaces between ducts with concrete;
  4. enclose ducts in a minimum 75 mm (3") thick envelope of concrete for full width of trench;
  5. fill entire space between ducts with concrete; do not use concrete which has started to set to a point that it will not properly pour to smoothly fill spaces between and around ducts;
  6. use of monolithic method (i.e. placing all ducts and pouring concrete around complete installation) is subject to approval of local governing authority and review with Consultant;
  7. exercise with care when placing concrete around ducts to ensure that ducts remain in correct position with proper spacing and that no concrete enters any of ducts;
  8. reinforce duct where duct crosses filled or disturbed ground;
  9. there must be no metallic reinforcing rods or other conducting material encircling a single conduit in a duct bank (entire duct bank may be encircled);
  10. maximum size of aggregate in concrete to be 10 mm (3/8");
  11. provide reinforcing rods and dowels in ductbank at building wall as detailed;
  12. provide sloping and drainage of ducts to prevent pooling of water within ducts; review requirements with Consultant prior to start of Work;
  13. unless drainage provisions have been provided within building for duct draining, seal openings where ducts enter building with elastomeric, fire rated, waterproof sealing material to prevent egress of water and that can easily be removed for access to ducts;
  14. provide marking tape and marking pavers as required by local governing authorities;
  15. provide one (1) continuous length of polyethylene rope or Brantford twine in each duct indicated as spare or for future use.
10. Allow Consultant and local authority representative (as applicable) access and opportunity to witness Work, prior to covering.
11. Refer to requirements of drawing detail.

### 3.2 INSTALLATION OF TRANSFORMER PAD

1. Provide specified transformer pad and foundation in accordance with local governing electrical utility's requirements, in location as shown and as detailed on drawings. Coordinate required excavation, backfill, and concrete work. Refer to Section entitled Basic Electrical Materials and Methods for excavation, concrete, and backfilling work requirements. Arrange and coordinate work to prepare ground to provide a level and good draining foundation for pad and transformer. Coordinate cable entry opening with location of duct bank.

2. Installation to be in accordance with local governing electrical Utility's requirements and with generally accepted trade practices. Exact requirements to be confirmed with local governing electrical Utility.
3. Provide duct drainage as required.
4. Provide guard posts as required.
5. Provide grounding as required by local governing electrical authority. Also refer to requirements of Section entitled Grounding and Bonding.
6. Perform work under general supervision of General Contractor.

### **3.3 INSTALLATION OF HANDHOLES/JUNCTION BOXES**

1. Coordinate installation work with trades responsible for excavation and backfilling work.
2. Install handholes/boxes plumb, true to alignment and grade, and firmly bedded on drainage pocket backfill.
3. During installation, duct entry holes to be oriented in required direction. Enlarging of duct entry holes is prohibited.
4. Coordinate connection of ducts to ensure that proper sloping is maintained to suit designed elevations and slope of duct run and required drainage.
5. Refer to drawing detail for additional requirements.
6. Comply with grounding and bonding requirements of local governing electrical codes and authorities.
7. Confirm drainage provisions and provide as required. Coordinate work with General Contractor to connect drains.
8. Obtain required approvals of work from local governing electrical utility and review with Consultant prior to back filling and covering.
9. Refer to Section entitled Basic Electrical Materials and Methods for excavation, concrete, and backfilling work requirements.

### **3.4 INSTALLATION OF MANHOLES**

1. Provide specified manholes. Coordinate required excavation, backfill, and concrete work. Arrange and coordinate work to prepare ground to provide a level and good draining foundation for manholes. Coordinate cable entry opening with location of duct bank.
2. Installation to be in accordance with local governing electrical utility's requirements and with generally accepted trade practices. Confirm exact requirements with local governing electrical utility.
3. Provide grade levelling collars/neck such that cover is flush with finished grade in paved areas and 38 mm (1-1/2") above grade in unpaved areas. Provide extension collars as required. Confirm final grade level with General Contractor.
4. Confirm drainage provisions and provide as required. Coordinate work with General Contractor to connect drains.
5. Coordinate connection of ducts and duct bank to ensure that proper sloping is maintained to suit designed elevations and slope of duct bank and required drainage.
6. Comply with grounding and bonding requirements of local governing electrical codes and authorities.
7. Work to be performed under general supervision of General Contractor.



8. Obtain required approvals of work from local governing electrical utility and review with Consultant prior to back filling and covering.
9. Refer to Section entitled Basic Electrical Materials and Methods for excavation, concrete and backfilling work requirements.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for following:
  1. cable tray with copy of ULC certificate and/or proof of CSA approvals;
  2. copy of installers' training certificate from manufacturer.
2. Submit detail drawings of proposed routing and dimensions.
3. Submit sample of trays as requested by the Consultant.

## 2 Products

### 2.1 BASKET CABLE TRAY

1. Legrand-Cablofil, CSA approved and labelled, or ULC listed, basket type cable tray system complete with factory made couplers, fittings, tee sections, elbows, universal dropouts, etc., and required supporting and installation accessories. Features include but are not limited to following:
  1. minimum 300 mm x 100 mm (12" x 4") unless otherwise noted on drawings;
  2. welded wire construction of minimum 5 mm (0.197") diameter carbon steel wires and hardware, conforming to requirements of ASTM A510 Grade 1008 with black powder coated finish paint to ASTM D3451;
  3. continuous, rigid, welded steel wire mesh cable tray system;
  4. top wire safety edge;
  5. wire mesh welded at intersections;
  6. mesh sections having minimum one bottom longitudinal wire along entire length;
  7. warning signs;
  8. accessories included as required.
2. Prior to start of work, prepare and submit detailed installation drawings, including plans, elevations and sections of proposed tray and routing. Coordinate such drawings with coordination drawings of trades. Include for design calculations to determine load limitations.
3. Tray to not have sharp edges that may damage cables during running of cables. Final finish to be smooth with no burrs that may damage cables.
4. Use manufacturer's trained and certified installers to perform work. Use tools as recommended by and supplied by tray manufacturer. Utilize manufacturer's supplied cutter for cutting tray. Submit with shop drawings, copies of installing technicians' certificates of training on respective tray systems.
5. Provide support of a trapeze configuration containing horizontal hanger brackets and vertical threaded rods on each side. Secure rods to brackets as per system manufacturer's instructions. Space supports at maximum 1.5 m (5'), to provide support of loads up to 53 kg/m (36 lbs per foot).
6. Where cable tray penetrates fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect integrity of fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide suitable for plenum environments.
7. Provide tray complete with manufacturer's pre-manufactured accessories including but not limited to:
  1. splices, tee sections, elbows and braces to join and run tray in required configurations;
  2. cable exits and dropouts as required to protect cables when entering and exiting tray;
  3. conduit attachment fittings and clamps as required to connect conduits to tray;
  4. grounding/bonding hardware provisions to maintain ground continuity;

5. dividers to separate various system cabling to degree reviewed with Consultant, but typically two dividers in 300 mm (12") wide tray;
6. cable installation rollers for pulling cables safely into tray;
7. mounting brackets, supports and seismic restraints to suit specific applications;
8. top covers and bottom inserts to protect cables, as required
8. System accessories matching construction material of tray, to be supplied by system manufacturer to suit specific applications.
9. Manufacturer to provide installer with required certified training of installation of tray system.
10. Acceptable Manufacturers:
  1. Legrand-Cablofil.
  2. Eaton "Flextray"
  3. Canadian Electrical Raceways.
  4. Hubbell.
  5. WBT.

### 3 Execution

#### 3.1 INSTALLATION OF CABLE TRAY

1. Provide sample of tray and detailed drawing layout of work prior to start of work, accurately dimensioned and showing required routing, penetrations, connections, bends, supports, etc.
2. Obtain required training from manufacturer's representative on any special installation procedures. Install tray in accordance with manufacturer's instructions to suit specific installation requirements. Use manufacturer's recommended tools for cutting and installing tray.
3. Drawings are diagrammatic and do not identify required changes in elevations and architectural features. Site measure exact routing and lengths. Provide detailed drawing layout of work prior to start of work, accurately dimensioned and showing required penetrations, connections, bends, etc.
4. Install and hang cable tray at maximum 1.5 m (5') centres and in accordance with manufacturer's published literature employing horizontal bracket supported to ceiling slab by vertical threaded rod hangers. Do not secure assembly from ductwork, suspended ceiling structures, lighting, etc. Secure rod hangers directly to ceiling slab. Locate supports as not to interfere with removal or opening of covers. Typically locate spans at intervals  $\frac{1}{4}$  span from supports, as recommended by tray manufacturer. Refer to drawing details and/or manufacturer's instructions. Include for provision of required seismic restraints as to comply with local governing building code requirements.
5. Provide proper fittings in cable tray at points of conduit entry. Terminate conduits at or in tray with proper grommetted and bushed terminations.
6. Equip tray with necessary wall flanges, dropouts, enclosures, reducers, fittings, and similar accessories required, maintaining effective free cross-sectional area of tray clear of obstructions that might damage conductor insulation during installation. Accessories are to be typically pre-manufactured by manufacturer to suit specific applications.
7. Properly secure, adequately support and neatly harness conductors in tray. Seal cable tray penetrations of building fire barriers by means of ULC listed and labelled fire stopping and smoke sealing material.
8. Provide continuous paths along entire lengths of cable tray to maintain proper ground continuity. Utilize system manufacturer's proper grounding and bonding fittings and hardware. Ground and bond system as per local governing electrical code requirements.
9. File smooth cuts to tray and re-touch with galvanizing compound.
10. Install expansion connectors where cable tray crosses building expansion joints.

11. When installing cables into tray, do not exceed manufacturer's recommended load capacities for tray.
12. After installation is complete, install warning signs on tray in visible locations.
13. Inspect tray for rough finishing burrs, sharp edges, and mechanical deficiencies prior to installing of cabling. Eliminate these deficiencies to satisfaction of Consultant, prior to installing cables.

**END OF SECTION**

## **1 General**

### **1.1 INTRODUCTION**

1. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications.
2. Contractor shall coordinate all of the work in this section and all of the trades covered in other sections of the specification to provide a complete and operable system.
3. The contractor shall assume all responsibility for the co-ordination, delivery, installation, testing and commissioning of the system, including all associated work, submission and approval of shop drawings.

### **1.2 DESCRIPTION OF WORK**

1. Provide a lighting control system as indicated on the drawings and as specified here-in. the lighting control system shall include, but not limited to:
  1. Low voltage switching system with lighting automation relay panels, associated low voltage switches, and occupancy sensors.
  2. Fully Programmable panel intelligence cards with:
    1. Network Overrides
    2. Programmable system switches
    3. Telephone overrides
    4. Central Monitor/Control/Programming software.
    5. Factory service
      1. Startup
      2. Training
      3. Documentation
      4. Programming
  3. Types of lighting control equipment and wiring specified in this section include the following:
    1. Low Voltage Lighting Automation Relay Panels
    4. Refer to the specifications on the drawings for work including, but not limited to, raceways and electrical boxes and fitting required for installation on control equipment and wiring.

### **1.3 QUALITY ASSURANCE**

1. Manufacturers: Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
2. Component Pretesting: All components and assemblies are to be factory pretested and burned-in prior to installation.
3. System Checkout: Factory trained technicians shall be available to functionally test each component in a programmable system after installation to verify proper operation and confirm that the panel wiring and addressing conform to the wiring documentation.

4. System Support: Factory applications engineers shall be available for on-site training as well as telephone support.
5. OESC Compliance: Comply to Ontario Electrical Safety Code as applicable to electrical wiring work.
6. CSA/ULC Compliance: Comply with applicable portions of CSA and ULC standards pertaining to types of electrical equipment and enclosures.
7. ULC/CSA Approvals: Remote panels are to be UL listed under UL 916 Energy Management Equipment and CSA approved.
8. FCC Emissions: All assemblies are to be in compliance with FCC emissions Standards specified in Part 15 Subpart J for Class A application.

#### 1.4 SUBMITTALS

1. Product Data: Submit manufacturer's data on lighting control system and components.
2. Shop Drawings: Submit dimension drawings of all lighting control system components and accessories.
3. One Line Diagram: Submit a one line diagram of the system configuration proposed if it differs from that illustrated in the riser diagram included in these specifications.
4. Typical Wiring Diagrams: Submit typical wiring diagrams for all components including, but not limited to, relay panels, relays, low voltage switches, occupancy sensors, programmable panel master switches, programmable system switch panels, telephone override modules, data communications devices and wire, and the central operator PC.

## 2 Products

### 2.1 ACCEPTABLE MANUFACTURERS

1. This specification and part numbers are based on the GE TLC system and shall be used as reference for the minimum requirements and quality of materials. Each manufacturer shall present their product to the Owner and Consultant and demonstrate compliance with the specification.
2. The low voltage lighting control system shall be as manufactured by:
  1. Leviton.
  2. Lutron.
  3. Acuity nLight.
  4. Encelium.
  5. Crestron.

### 2.2 MATERIALS AND COMPONENTS

- .1 Photocell:
  - .1 Automatic ON/OFF switching photo control.
  - .2 Housing: Self contained, die cast aluminum, unaffected by moisture, vibration, or temperature changes.
  - .3 Setting:

1. Exterior: ON at dusk and OFF at dawn.
2. Interior: Control state (ON/OFF/DIMMING) according to low voltage signals.
- .4 Time delay feature to prevent false switching.
- .5 Field adjustable to control operating levels.
- .6 Voltage: low voltage and line voltage, refer to lighting control device schedule.
- .7 Shall be compatible with LED driver and/or lighting control system.
- .2 Occupancy Sensors:
  - .1 Dual Technology Units:
    1. Unit to be ceiling mounted for 180 degree or 360-degree coverage. Locate and aim sensors to achieve best coverage of controlled areas per the manufacturer's recommendations.
    2. Unit shall utilize both passive infrared and ultrasonic technologies and be easily programmed to accommodate different environmental and architectural conditions.
    3. Unit must detect up to 2,000 square feet with no blind spots.
    4. No audio dual technology units will be accepted.
    5. Control setting: Occupancy mode/ Vacancy mode/ Dimming mode, according to low voltage signal. Refer to sequence of operation on electrical drawings.
    6. Voltage: low voltage and line voltage, refer to lighting control device schedule.
    7. Shall be compatible with LED driver and/or lighting control system.
  - .2 Power Packs:
    1. Able to mount through a 13 mm knock out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low voltage power. Transformer shall provide power to a minimum of two sensors.
    2. Relay contacts shall have ratings of: 20A, 120V AC driver.
- .3 Wiring: Control wiring between sensors and control units shall be Class II, 14 AWG, stranded, PVC insulated, or Teflon jacketed cable approved for use in plenums, where applicable.
- .4 General:
  1. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to cycling of air conditioner or heating fans.
  2. Sensors shall have readily accessible, user adjustable controls for time delay and sensitivity.
  3. In event of failure, bypass manual OVERRIDE ON key shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
  4. Power Packs shall have an extra Form C (1 NO 1 NC) contact for interface with building system. Units shall be designed to be mountable in standard electrical box.
  5. All lighting control devices shall be compatible with the overall lighting system.

### 3 Execution

#### 3.1 SUPPORT SERVICES

##### 1. Service Description

1. System Startup
2. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all system components.
3. Training
  1. Manufacturer shall provide factory authorized application engineer to train Owner personnel in the operation and programming of the lighting control system.
4. Documentation
  1. Manufacturer shall provide system documentation including:
    1. System 1-line showing all panels, number and type of switches and sensors, dataline, programmable system switches, telephone override modules, and central PC.
    2. Drawings for each panel showing hardware configuration and numbering.
    3. Panel wiring schedules
    4. Typical wiring diagrams for each component.
    5. Programming
    6. Manufacturer shall provide system programming including:
      7. Wiring documentation
      8. Programmable Panel and System Switch Operation
      9. Telephone Overrides
      10. Operating Schedules.
  2. These shall be provided on floppy disk compatible with the central PC's Lighting Control Program.

**END OF SECTION**



## **1 General**

### **1.1 SUBMITTALS**

1. Submit shop drawings for products specified in this Section.

### **1.2 LOCAL ELECTRICAL UTILITY REQUIREMENTS**

1. Comply with latest conditions of supply requirements of local governing electrical utility. Confirm exact requirements with local governing electrical utility and coordinate utility requirements with respective Divisions of Work providing such work. Provisions to accommodate local governing electrical utility requirements generally include but are not limited to following:
  1. preconstruction meeting;
  2. inspection: on site access for local governing electrical utility inspector to be on duty for duration of work;
  3. underground inspection: submission of approval drawings and application for inspection prior to any inspection of work;
  4. approval of work and materials by local governing electrical utility inspector prior to any backfilling work.
2. In case of discrepancies or conflicts between Drawings and Specifications and local governing authority standards, contact Consultant and obtain direction. If direction is not available prior to close of Bids, include for most costly arrangement, but ensure that direction is obtained prior to start of Work.

### **1.3 INCOMING ELECTRIC SERVICE WORK**

1. Included in Division 01 is a cash allowance to cover costs for local governing electrical utility to extend their electrical system to service property. Local governing electrical utility work to include but not be limited to provision of following:
  1. primary conductors and secondary conductors installed in concrete encased ductbank;
  2. required primary and secondary connections to main power transformer;
  3. pad mounted main power transformer;
  4. testing of primary conductors, main power transformer and connections;
  5. required off site work to incoming system;
  6. low voltage metering components.

### **1.4 PROTECTIVE COORDINATION AND EQUIPMENT WITHSTAND RATINGS**

1. Obtain results of coordination study and short circuit calculations reports and Consultant comments and incorporate into shop drawings of electrical distribution equipment (high voltage and low voltage equipment as applicable). Do not order equipment until shop drawings submission process has been completed and reviewed with Consultant.
2. Provide ratings for electrical equipment, circuit protective devices, bussing, and switches to interrupt and withstand short circuit faults greater than available fault current at its source of supply.

### **1.5 BREAKERS**

1. Breakers to be NEMA rated types, and for switchboards and distribution panelboards, breakers when frame sized greater than 225 amperes, or where scheduled or where noted on drawings, to be provided with solid state adjustable trip units with long time, short time and instantaneous time (LSI) functions and time delays. Set trip units at ratings as per coordination study as required for proper selective coordination. Unless otherwise noted on drawings, provide ground fault alarm and trip functions at breaker trip unit rating above 600 A, and set as coordinated with results of coordination study and as reviewed with Consultant.

2. Size breakers as per drawings and/or schedules, but in absence of direction, size breakers to suit intended application, to suit coordination study requirements and in accordance with local governing electrical code.

## 2 Products

### 2.1 SPLITTER TROUGH

1. CSA approved, splitter trough each complete with:
  1. formed, factory primed and painted steel box with knockouts;
  2. hinged front coverplate;
  3. suitable mounting provisions;
  4. a nameplate giving its rating.
2. Terminal blocks consist of pressure type main lugs and branch lugs approved for copper wiring and mounted on porcelain bases.
3. Enclosures for splitters mounted in climate controlled areas to be NEMA 1. For standard non-climate controlled applications, enclosures to be minimum NEMA 3R. Use NEMA 4X for corrosive environment applications.
4. Splitter trough ratings are scheduled on drawings.
5. Acceptable manufacturers are:
  1. Bel Inc.;
  2. Hydel;
  3. Hammond.

### 2.2 CONTACTORS

1. Eaton, CSA approved, NEMA rated, factory assembled, magnetic, full voltage contactors as follows:
  1. To CSA C22.2 No.14;
  2. "Freedom" CN15 series, non-reversing type for heating and motor loads; features long life twin break, silver cadmium oxide contacts and steel mounting plate; magnetically actuated switch to include remote operation capability;
  3. Series A202 electrically held, magnetically latched contactor for lighting loads; contactors designed to withstand large initial inrush currents.
2. Each contactor to be suitable in respects for application and complete with following, as applicable:
  1. "Hand-Off-Auto" switch and pilot lamp;
  2. "START/STOP" pushbutton;
  3. an enclosure of NEMA size to suit application with necessary accessories;
  4. factory primed and painted enclosures;
  5. minimum NEMA 1 type enclosures for climate-controlled areas;
  6. minimum NEMA 3R type enclosures for non-climate-controlled areas;
  7. ampere rating, number of poles, etc., as noted on drawings.
3. Acceptable manufacturers are:
  1. Eaton;
  2. Schneider Electric (Square D);
  3. Rockwell Automation (Allen-Bradley);
  4. Siemens.

## 2.3 DISCONNECT SWITCHES

1. Heavy duty, CSA approved, disconnect (safety) switches. Features include:
  1. front operated with handle suitable for padlocking in "OFF" position and arranged so that enclosure cover cannot be opened while handle is in "ON" position;
  2. operating mechanisms: quick-break, positive acting with visible blades and line terminal shield;
  3. 100% load break / make rated;
  4. non-fusible units;
  5. fusible units with fuse clips suitable for HRC fuses, unless otherwise noted;
  6. ampere rating, number of poles and fuse requirements as indicated on drawings;
  7. factory primed and painted switch enclosures.
2. Disconnects for variable speed drives to be suitable for use with such drives and include auxiliary switch/contact to de-energize control power circuit, as required and as applicable.
3. Enclosures for disconnects mounted in interior climate-controlled areas and standard non-climate controlled areas to be NEMA 3R. For corrosive environmental applications, enclosures to be minimum NEMA 4X.
4. Acceptable manufacturers are:
  1. Eaton;
  2. Siemens Electric Ltd.;
  3. Schneider Electric (Square D).

## 2.4 DOUBLE THROW DISCONNECT SWITCHES

1. Heavy duty, CSA approved, double throw disconnect switches. Features include:
  1. front operated handle operating mechanism actuates either upper or lower switch; when handle is in centre position, both switches are OFF;
  2. handle and door interlocked to keep door closed when switch is ON and hold handle OFF when door is open;
  3. triple padlocking – 2 on door and up to 3 locks in centre OFF position;
  4. 100% load break / make rated;
  5. non-fusible units;
  6. fusible units with fuse clips suitable for HRC fuses, unless otherwise noted;
  7. ampere rating, number of poles and fuse requirements as indicated on drawings;
  8. factory primed and painted switch enclosures.
2. Enclosures for disconnects mounted in interior climate-controlled areas and standard non-climate controlled areas to be NEMA 3R. For corrosive environmental applications, enclosures to be minimum NEMA 4X.
3. Acceptable manufacturers are:
  1. Eaton;
  2. Siemens Electric Ltd.;
  3. Schneider Electric (Square D).

## 2.5 FUSES

1. Unless otherwise indicated, fuses to be Form I, Class "J" HRC fuses for constantly running equipment, and Form II, Class "C" HRC fuses for motorized equipment that cycle "ON" and "OFF".
2. Unless otherwise indicated, fuses for use in motor control centres and motor starters to be equivalent to Mersen Class "J" type "AJT", dual element time delay type and in accordance with UL standards 248-8 and 198L.

3. Fuses to be of type suitable for applications as required by local governing electrical codes and in coordination with respective equipment manufacturer's recommendations in which fuses are required. Coordinate also with Mechanical Division Contractor for requirements for Mechanical Division equipment.
4. Fuses to be of product of one manufacturer.
5. Acceptable manufacturers are:
  1. Mersen (Ferraz Shawmut);
  2. English Electric Ltd.;
  3. Noram;
  4. Cooper Bussmann.

## **2.6 FUSE CABINET**

1. Fuse storage cabinet, surface wall mounted, manufactured from aluminum, approximately 750 mm (30") high, 600 mm (24") wide, 300 mm (12") deep, with provisions for supporting fuses and hinged lockable front access door. Cabinet to be finished in grey enamel paint and include identification labelling.

## **3 Execution**

### **3.1 INCOMING ELECTRIC SERVICE WORK**

1. As confirmed with local governing electrical utility, include for but not be limited to provision of following:
  1. provision of secondary concrete encased ductbank;
  2. provision of manholes;
  3. provision of foundation padmount and grounding provisions for local electrical utility main power transformer;
  4. provision of protection bollards around pad mount transformer;
  5. provision of secondary conductors installed in concrete encased ductbank;
  6. coordination with local electrical utility for their secondary connections to main power transformer;
  7. testing of secondary conductors;
  8. coordination with local electrical utility for their low voltage metering components.
2. Review incoming cables and duct/conduit runs from utility source and comply with local governing utility requirements for installation of cables and duct/conduit runs to Owner service entrance equipment. Obtain required local governing utility details, inspections and approvals.

### **3.2 INSTALLATION OF SPLITTER TROUGH**

1. Provide splitter trough and install into locations and connect complete. Install with adequate clearance as per code requirements and as required for access for operation and maintenance.
2. Ensure enclosure ratings are suitable for intended applications.
3. Secure splitter trough in place independent of connecting conduit, secure into position and connect complete.
4. Provide engraved lamacoid nameplate with nomenclature reviewed with Consultant.

### **3.3 INSTALLATION OF CONTACTORS**

1. Provide contactors in enclosures for electric heating, outside lighting control and other equipment. Connect complete to equipment and auxiliary control devices as required.
2. Wall mount each enclosure independent to panelboard to which loads are connected.
3. Ensure enclosure ratings are suitable for intended applications.
4. Provide engraved lamacoid nameplate with nomenclature reviewed with Consultant.

### **3.4 INSTALLATION OF DISCONNECT SWITCHES**

1. Provide disconnects switches and install into locations and connect complete. Ensure adequate clearance is provided as per local code requirements and as required for access for operation and maintenance. Install as follows:
  1. wherever shown on drawings and/or specified herein;
  2. wherever required by MCC/VFD/starter schedule drawings;
  3. for motorized equipment which cannot be seen from motor starter location or is more than 9 m (30') from starter location (in accordance with local governing electrical code requirements);
  4. for "packaged" equipment fed from a motor starter panel.
2. Where double throw switches are required, connect to provide operations as noted.
3. Ensure enclosure ratings are suitable for intended applications.
4. Provide engraved lamacoid nameplate with nomenclature reviewed with Consultant.

### **3.5 INSTALLATION OF FUSES**

1. Install fuses in mounting devices immediately before energizing circuit.
2. Ensure correct fuses fitted to physically matched mounting devices.
3. Ensure correct fuses fitted to assigned electrical circuit.
4. Provide a complete set of fuses for each fusible disconnect, motor starter, and similar fusible equipment provided or supplied.
5. Supply 3 spare fuses of each size and type used on project, mount fuses in cabinet. Secure cabinet in wall location as reviewed with Consultant.

### **3.6 PROVISIONS FOR BUILDING AUTOMATION SYSTEM**

1. Provide alarm/communications circuits as required. Include for provision of conduits, boxes and control/signal wiring for interconnection to BAS. Coordinate with Mechanical Divisions BAS Contractor on location of BAS panel to be used for monitoring points and extend wiring in conduit from electrical equipment to location. Terminate in junction box leaving 3 m (10') of slack length of wiring (exact length to be coordinated between Mechanical and Electrical trades), for extending and termination to BAS panel by Mechanical Division BAS Contractor. Properly identify wiring and junction box.

### **3.7 ELECTRICAL CONNECTIONS FOR MECHANICAL, OWNER'S, ETC., EQUIPMENT**

1. Provide required electrical connections to apparatus provided and/or supplied by Electrical Divisions. Review shop drawings and coordinate with each equipment vendor, requirements for power feeds and control/communication interconnections and provide these requirements to complete installations work.
2. In addition to providing electrical feeders and connections to equipment provided by Electrical Divisions, provide required electrical connections to apparatus provided and/or supplied by Mechanical Divisions, Owner and as part of other Divisions.
3. Unless otherwise noted, provide electrical connections including power and control wiring for equipment supplied by Owner or by other Divisions, and except where specified for control wiring of Mechanical Divisions automatic control systems specification Section. Provide complete wired and empty conduit systems with fish cord, junction boxes, pull boxes, outlet boxes, faceplates, sleeves, etc. Provide disconnect switches, receptacles and other required wiring and connection accessories. Coordinate work with respective Consultants and suppliers of equipment to be provided with electrical connections.
4. Refer to Divisions 10 and 11 and include for coordination and interconnections of Divisions 10 and 11 requirements and equipment schedules.

5. Coordinate with trades of other Divisions to ensure provision of proper electrical requirements. Unless otherwise noted or reviewed with Consultant, be responsible for provision of interconnect wiring between remote operator devices, controllers, and equipment being controlled by operator devices, whether or not such devices/controllers are supplied by Electrical Divisions. Where equipment is of split unit design and line voltage is required to both units, be responsible for feeders to each unit as coordinated with equipment manufacturer and Division responsible for equipment. Provide disconnect switches, receptacles and other required wiring and connection accessories. Provide system/equipment power feeds with hard wired or receptacle type connections, as required. Coordinate exact requirements prior to start of work, at time of shop drawing submissions and prior to roughing-in of work. Coordinate work with suppliers of equipment to be provided with electrical connections which may include but not be limited to following:
  1. kitchen equipment;
  2. telecommunication systems;
  3. mechanical systems and equipment;
6. Provide coordination of alarm connections of equipment with Mechanical Divisions BAS Contractor. Refer to drawings of both Electrical Divisions and Mechanical Divisions for BAS points to be connected. Include for wiring in conduit, contacts, termination/junction boxes, etc., as required for inter connection.
7. Mechanical Divisions are responsible for supply of motor control centres (MCCs), motor starters and variable frequency drives (VFDs) (also known as variable speed drives –VSDs) and harmonic filters for motorized apparatus supplied by them and is to provide Lamacoid identification throughout. Motor starters, VFDs and/or MCCs are generally to be as scheduled. Generally, starters are supplied in following manner:
  1. loose starters for mounting adjacent to apparatus or on motor starter panels;
  2. mounted starters in factory assembled and pre-wired motor control centres;
  3. mounted starters on factory assembled and pre-wired packaged equipment.
8. MCCs and VFDs (with harmonic filters where required) are to be supplied and set in position by Mechanical Divisions. Coordinate installation and connection requirements with Mechanical Divisions and respective equipment manufacturers. Obtain required wiring diagrams. Provide required connections.
9. Be responsible for following work:
  1. mounting loose starters and providing "line" and "load" power connections;
  2. providing motor starter panels - conduit work at motor starter panels to be horizontally and vertically plumb; plan installation to avoid crossovers;
  3. making "line" side power connections to motor control centres and "load" side connections to motors or other apparatus supplied power from motor control centres - where applicable, sub-feed refrigeration machine starter from double lugs furnished in adjacent motor control centre for refrigeration equipment;
  4. making "line" side power connections to starters on "packaged" equipment;
  5. coordinating feeder entries to starters and starter assemblies with Mechanical Divisions;
  6. providing additional disconnect switches (complete with identification) detailed on drawings, or required by Code, or for apparatus which cannot be seen from its starter or is in excess of 9 m (30') from its starter;
  7. connections to thermistors and provision of additional relays as required for connections to starters; generally, Mechanical Divisions are to supply required thermistors and relays necessary for starters; review Mechanical Divisions specifications and/or drawings defining these requirements and include necessary work, wiring, conduit and components not being supplied by Mechanical Divisions;
  8. performing required motor starter interlocking in accordance with requirements specified and as outlined on MCC/starter schedules; coordinate interlocking requirements with Mechanical Divisions;

9. in coordination with Mechanical Division, providing 120 VAC power feeds to receptacles and luminaires integral with mechanical equipment including air handling units;
  10. in coordination with Mechanical Division, ensure that identification nameplate is provided on each motor starter or disconnect;
  11. in coordination with Mechanical Division, ensure that identification nameplate is provided on each motor control centre nameplate is to identify name, for example, MCC No. 1, and voltage, for example, 600 V;
  12. in coordination with Mechanical Division, ensure that identification nameplate is provided and attached with stainless steel screws to each separately mounted 3-phase motor starter or group of 3-phase motor starters a suitably sized black-white-black Lamacoid nameplate engraved to read:

"MOTOR(S) IS CAPABLE OF MAKING TWO (2) STARTS IN SUCCESSION, COASTING TO REST WITH APPROXIMATELY 15 MINUTES ELAPSED TIME BETWEEN STARTS, WITH MOTOR INITIALLY AT AMBIENT TEMPERATURE, OR OF MAKING ONE (1) START WITH MOTOR INITIALLY AT A TEMPERATURE NOT EXCEEDING ITS RATED LOAD OPERATING TEMPERATURE, IF  $\Omega K^2$  OF LOAD, LOAD TORQUE DURING ACCELERATION, APPLIED VOLTAGE AND METHOD OF STARTING ARE THOSE FOR WHICH MOTOR WAS DESIGNED."
  13. Replace motors due to abuse of above prior to acceptance of work. If additional starts are required, it is recommended that none be made until conditions affecting motor operation have been thoroughly investigated and apparatus examined for evidence of excessive heating. Restrict number of motor starts to absolute minimum since life of motor is affected by number of starts.
  14. Where supplied by Mechanical Divisions and connected by Electrical Divisions, connect VFDs and harmonic filters with power, control and monitoring conductors in strict accordance with manufacturer's instructions and local governing electrical code. Provide manufacturer's recommended conductors and connectors to suit respective connected equipment (such as Nexan DriveRX type VFD cables). Provide required upstream fused disconnects or breakers and overload protection. Maintain separation of power and control conductors as per manufacturer's requirements to minimize effects of electromagnetic interference. Properly ground and bond equipment. Coordinate exact installation requirements with Mechanical Division and equipment vendors.
10. Refer also to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.

## 2 Products

### 2.1 DRY TYPE TRANSFORMERS – GENERAL REQUIREMENTS

1. Types, capacities and ratings: as noted or scheduled on drawings.
2. CSA approved and/or ULC listed and labelled, constructed and factory tested in accordance with applicable requirements of following:
  1. Canadian Standards Association (CSA)
    1. CAN/CSA-C22.2 No.47, Air-Cooled Transformers (Dry Type).
    2. CAN/CSA-C802.2, Minimum Efficiency Values for Dry Type Transformers.
    3. CSA C9, Dry-Type Transformers.
  2. Institute of Electrical and Electronics Engineers (IEEE)
    1. IEEE C57.110, IEEE Recommended Practice for Establishing Liquid Immersed and Dry-Type Power and Distribution Transformer Capability when Supplying Nonsinusoidal Load Currents.
  3. National Electrical Manufacturers Association (NEMA)
    1. NEMA ST 20, Dry Type Transformers for General Applications.
  4. National Research Council Canada (NRCC)
    1. NRCC SOR/2016 – 311, Energy Efficiency Regulations.
  5. U.S. Department of Energy (DOE)
    1. DOE 10 CFR 431.196, Code of Federal Regulations, Energy Efficiency Program for Certain Commercial and Industrial Equipment.
  6. Local governing authority codes and standards.

### 2.2 DRY TYPE DISTRIBUTION TRANSFORMERS

1. Hammond Power Solutions, "Sentinel G" series dry type transformers as noted or scheduled on drawings, CSA approved and/or ULC listed and labelled. Transformers to be constructed and factory tested in accordance with applicable requirements of above codes and standards, and other local governing authority codes and standards.
2. Transformers to be complete with:
  1. copper windings;
  2. Class "H", 220°C class, coil insulation, such that winding temperature rise to not exceed 150°C(270°F) and enclosure temperature rise not exceed 65°C(117°F) under full load in a 40°C (104°F) ambient temperature;
  3. core construction consisting of stacked laminations of high permeability silicone steel;
  4. vacuum impregnated polyester or epoxy resin;
  5. lugs or pressure type terminals to suit primary and secondary conductors;
  6. up to 15 kVA: two - 5% full capacity taps; one above normal and one below normal; taps located on primary winding;
  7. greater than 15 kVA: four - 2-1/2% full capacity taps; two (2) above normal and two (2) below normal; taps located on primary winding;
  8. an integral vibration dampening system with anti-vibration pads used between coil and core and enclosure;



9. seismic restraint requirements to suit local governing authority requirements and codes;
  10. unless otherwise noted, basic impulse level to meet CSA C9 standards;
  11. unless otherwise noted, average sound level to meet NEMA ST-20 and CSA C9 standards;
  12. efficiency meeting or exceeding latest efficiency levels of listed above standards;
  13. unless otherwise noted, factory painted with an ANSI grey enamel finish as reviewed with Consultant and approved by Owner;
  14. aluminum nameplate indicating impedance rating, weight, connection diagram, style and serial number, riveted to front of enclosure.
3. Acceptable manufacturers are:
1. Hammond Power Solutions;
  2. Delta Group;
  3. Schneider Electric;
  4. REX Power Magnetics;
  5. Siemens;
  6. Eaton.

### 2.3 ENCLOSURES AND DRIP SHIELDS

1. Include following:
  1. for standard indoor applications: minimum NEMA 2 ventilated, drip proof enclosure with rigid end frame, removable plates, terminal compartment;
  2. top mounted factory painted drip shield;
  3. bottom mounted drip tray for wall/ceiling mounted transformers;
  4. unless otherwise noted, factory painted with an ANSI grey enamel finish as reviewed with Consultant and approved by Owner.

## 3 Execution

### 3.1 INSTALLATION OF DISTRIBUTION TRANSFORMERS

1. Locate transformers into position. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance. Ensure that there is adequate ventilation for transformers to operate as specified and that there is no transfer of heat to adjacent surfaces or equipment. Comply with manufacturer's instructions and recommendations.
2. Secure transformers 75 KVA and larger to a concrete housekeeping pad on Vibro-Acoustics Ltd. type "RSR" vibration isolation pads.
3. Secure transformers smaller than 75 KVA in place on an angle wall mounting bracket support assembly located approximately 300 mm (12") below ceiling. Provide support assembly and adequately secure to wall and/or ceiling construction.
4. Provide seismic restraints as required by local governing codes.
5. Ensure that transformers are equipped with lugs or connections suitable for primary and secondary connections. Isolate primary and secondary connections from transformer enclosures by means of 300 mm - 450 mm (12" to 18") of liquid-tight flexible conduit. Typically, install conduit connections in lower one-third of transformer.
6. Ground and bond equipment to ground electrode grids as per local governing electrical code and inspection authority requirements. Refer also requirements of Section entitled – Grounding and Bonding.
7. Provide engraved Lamacoid nameplates and warning signs with nomenclature reviewed with Consultant.

8. When installation is complete, test and check secondary voltages. Make all required adjustments and submit to Consultant a test report indicating secondary voltage readings and any adjustments made to achieve proper voltages. Furthermore, when building is in normal use, re-check voltages and make any required adjustments.
9. Refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.
2. Revise equipment ratings to suit coordination study and short circuit calculations reports.

### 1.2 BREAKERS

1. Refer to Section 26 20 00 - Part 1, for general requirements for breakers.

## 2 Products

### 2.1 STANDARD SWITCHBOARDS

1. Eaton, "Pow-R-Line C", indoor, metal enclosed, standardized service entrance switchboard for use in a solidly grounded system with a short circuit capacity as scheduled. Switchboard is shown and scheduled on drawings and complies with latest editions of following:
  1. CSA Standard CAN/CSA C22.2 No. 31;
  2. UL 891.
2. Moulded case breakers are to comply with and be designed, manufactured and tested in accordance with applicable conditions of:
  1. C22.2 NO. 5;
  2. UL 489.
3. Switchboard conforms to local governing electrical authority requirements.
4. Structure:
  1. Switchboard consists of individual sections bolted together to form an enclosed, self-contained, self-supporting structure with necessary facilities for proper ventilation. Switchboard is front accessible type needing no access from rear. Sections to align front and rear. Each section is of modern welded construction, fabricated from sheet steel in accordance with NEMA and CSA requirements and reinforced wherever necessary to provide adequate strength. Front panels or doors are formed type, fabricated with cold rolled sheet steel. Unless otherwise required, rear, top and side panels are bolt-on and secured suitably to a channel type base. After fabrication, switchboard is factory cleaned and finished with ANSI grey enamel.
  2. Entire enclosure to be in accordance with NEMA 1 or NEMA 2 requirements, and with additional sprinkler protection requirements. Top of each cell to be complete with a "drip-shield" designed to shed water without dripping on cell. Enclosures to be designed to prevent penetration of water spray from activated sprinklers, onto live components. Doors and component openings to be gasketed. Conduit entries to be sealed watertight.
5. Future Cells:
  1. Where shown, provide bus terminations for future extensions and gasketed water-tight removable side panels to accommodate installation and connection of future cells.
6. Bus Bars:
  1. Main bus bars are constructed of top quality, 98% pure, rectangular copper bars, silver flashed, or silver plated at joints with lap type joints bolted using high strength steel bolts and extra wide, extra thick washers to ensure maximum pressure and even current distribution at each joint. Bus and connections are designed so that maximum temperature rise in any part of switchboard will not exceed 65°C (117°F) over an ambient temperature of 40°C (104°F). Bus is properly isolated and designed to carry currents as required.

2. Ground bus not less than 6 mm (1/4") x 50 mm (2") cross section area extending length of switchboard and is solidly bolted to steel framework. Ground bus is constructed of same material as main bus and is complete with suitable lugs for grounding connections outlined on drawings. Ground bus is rated for momentary current rating equal to or greater than that of apparatus in switchboard.
  3. Supply required bolts, nuts, and washers for field connection of bus joints between cells.
7. Control Wiring:
  1. Each cell to be complete with required control wiring and terminal blocks. Control wiring is type "SIS", minimum size No. 14, extra flexible wire with thermoplastic insulation. Neatly harness and suitably secure control wiring.
  2. Terminal blocks are of pressure type and complete with removable marking strips.
8. Switchboard Arrangement and Components:
  1. Switchboard cell arrangement and components are as detailed on drawings.
  2. Where 100% rated breakers are required, include necessary requirements.
9. Metering:
  1. Power Xpert Meter 2000 series (PXM 2260) microprocessor-based multifunction, power and energy meters with features as follows:
    1. accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions; meet accuracy requirements of IEC687 (class 0.2%) and ANSI C12.20 (Class 0.2%);
    2. provide per phase % THD (Total Harmonic Distortion) monitoring to the 40th order for voltage (reference to neutral only) and current, and provide Volts, Amps, kW, kVAR, PF, kVA, Frequency, kWh, kVAh, kVARh and 1 KYZ pulse output, on board meter limit exceeded alarms, and 512 Megabytes for data logging;
    3. include a three-line, bright red LED display;
    4. include serial communications: RS-485; of Modbus RTU, Modbus ASCII, DNP 3.0 protocols;
    5. include network communications: RJ-45 10/100 Base-T Ethernet Network port; Ethernet TCP/IP, Modbus TCP, BACnet/IP, SNMP v1 & v3 (Network), SMTP (email), HTTP, HTTPS, Atom Feed protocols;
    6. historical trend logging for graphical viewing from an embedded WEB server;
    7. to be configured and viewed from the on-board web server without the need for external software;
    8. I/O expandability through option card slot.
  2. Review exact requirements with Consultant prior to ordering.
10. Utility Metering Provisions:
  1. Confirm with and coordinate local electrical utility requirements and provide as required. Review exact requirements with Consultant prior to ordering.
  2. Metering cells for utility metering and current and potential transformers and associated fuses to suit utility requirements and respective applications. Supply current transformers (CT's) and potential transformers (PT's) to switchboard manufacturer, for factory installation into metering cells, and secondary to be connected to terminal blocks. Provide minimum 38 mm (1-1/2") diameter conduit stub in bottom of each metering cell for site extension of conduit to meters.
11. Current and Potential Transformers:
  1. Potential transformers (PT's) are of compartment type and incorporate current limiting fuses.
  2. Current transformers (CT's) have ratios to suit application, a mechanical rating equal to momentary rating of circuit breakers and insulated for full voltage rating of switchgear.

3. Current and potential transformers for local governing electrical utility metering are supplied by local governing electrical utility and are shipped to switchboard manufacturer's factory for factory mounting and connection.
12. Main Breakers:
  1. Series "C", frame type as scheduled and as required for application, sized as scheduled, fixed mounted, solid state moulded case circuit breaker with adjustable trip unit as specified in Part 1. Provide minimum interrupting capacity as scheduled.
  2. Breakers to be complete with "Digitrip-310" RMS sensing solid state trip unit having following adjustable tripping functions: long time pick-up, long time delay; short time pick-up; short time delay; instantaneous pick-up; ground fault pick-up; and ground fault delay. Trip settings to be as determined by distribution system testing and coordination study. Tripping unit to have three (3) sensors, one (1) on each phase conductor, arranged such that a trip signal from any sensor opens all three (3) poles of breaker.
  3. Breaker to be ULC listed for application of 100% of its trip setting and is be capable of carrying its full rated ampere capacity, indefinitely without tripping.
13. Circuit Breaker Distribution Section:
  1. Circuit breaker distribution section consists of Series "C" moulded case, bolt on circuit breakers with an interrupting capacity as scheduled and frame size to suit application. Refer to Part 1 for requirements of breakers to be provided with solid state adjustable trip units.
14. Surge Protective Devices (SPD):
  1. Switchboards to be complete with integral SPD unit installed in dedicated cell. Unit to be factory installed and connected onto bussing through integral disconnect as recommended by manufacturer. Unit to include diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts. Unit to be maintenance free.
  2. Refer to Section 26 43 00 for additional SPD requirements for switchboard.
15. Incoming and Outgoing Conductor Connection Facilities:
  1. Provide required facilities and hardware including cubicle for incoming feeder, and outgoing cable in conduit feeders.
16. Mimic Bus, Nameplates and Labelling:
  1. Red, single line vinyl bus approximately 3 mm (1/8") thick x 9 mm (3/8") wide, representing internal bussing and components, riveted to front of switchgear and extending through handles of respective breakers.
  2. Engraved Lamacoid nameplates to be secured with stainless steel screws, adjacent each panel component and identifying each component.
  3. Warning labels affixed on face of compartment doors that allow access to live components.
  4. Internally mounted devices labelled with designation matching drawings.
  5. Door mounted components suitably labelled to convey their function to operations personnel.
  6. Equipment rating plates identifying certifications and approvals and standards of compliance.
  7. Review finish colours, sizes, and nomenclature with Consultant prior to ordering.
17. Accessories:
  1. Manufacturer's standard accessories, spare parts and maintenance tool kit.
  2. Manufacturer's installation drawings.

18. Testing, Start-up, Verification and Training:

1. Manufacturer technician to:

1. perform standard factory testing and submit copy of detailed reports to Consultant for review;
2. assist installing Contractor in installation of equipment and to inspect installation; test equipment, perform start-up and verify work: coordinate work with Contractor;
3. be present to assist during third party testing;
4. perform testing at times reviewed with Consultant;
5. provide instructions on system operating and maintenance.

2. Refer to Part 3 for additional requirements.

19. Acceptable Manufacturers are:

1. Eaton;
2. Schneider Electric (Square D);
3. Siemens Electric Ltd.

### 3 Execution

#### 3.1 INSTALLATION OF SWITCHBOARDS

1. Provide switchboards and locate into positions. Base layout, design, connections and requirements for supplied accessories from documents and reviewed shop drawings. Carefully examine drawings and site conditions to ensure that equipment can be positioned into their designated positions, without difficulty. Install with adequate clearance as per code requirements and as required for access for operation and maintenance.
2. Coordinate cable (as applicable and referred to on drawings) entry location to match incoming cable. Allow sufficient space for required cable bending radii and connections. Where bus duct is used for connections, coordinate orientation to match and provide appropriate bus duct connection flanges.
3. Assemble individual sections of equipment in accordance with manufacturer's recommendations and instructions, and secure assembly to concrete base. Torque bus joint bolts to manufacturer's prescriptions.
4. Provide seismic restraints as required by local governing authorities and codes.
5. Coordinate delivery and installation of local electrical utility supplied metering transformers, as required.
6. Arrange for equipment manufacturer to provide necessary drawings for erection and installation of equipment. In addition, if required, obtain from manufacturer necessary copies of detail, erection, etc., drawings required for approval of installation from local electrical utility and any other authority having jurisdiction. Obtain required approvals and submit copies to Consultant.
7. Install controls and displays at height of between a minimum 1200 mm (4') to a maximum of 1800 mm (6') above finished floor level.
8. Provide alarm/communications circuits as required. Include for provision of conduits, boxes and control/signal wiring for interconnection to BAS. Coordinate with Mechanical Divisions BAS Contractor on location of BAS panel to be used for monitoring points and extend wiring in conduit from electrical equipment to location. Terminate in junction box leaving 3 m (10') of slack length of wiring (exact length to be coordinated between Mechanical and Electrical trades), for extending and termination to BAS panel by Mechanical Division BAS Contractor. Properly identify wiring and junction box.
9. Ground and bond equipment to ground electrode grids as per local governing electrical code and inspection authority requirements. Refer also requirements of grounding and bonding article.

10. Install and test SPD as per manufacturer's instructions.
11. Test remote alarms.
12. Test key operator locks and sequence of operation.
13. Arrange equipment in configuration as indicated on drawings and as per reviewed shop drawings.
14. Make necessary incoming and outgoing power cable connections to equipment in strict accordance with equipment and cable manufacturer's recommendations. Make connections and terminations and provide bus flanges suitable for specific incoming and outgoing cables/bus ducts.
15. Arrange for equipment manufacturer's personnel to provide inspection and testing of equipment prior to energizing system.
16. Provide engraved Lamacoid nameplates with nomenclature and confirm with Owner and review with Consultant, during shop drawing process.
17. Confirm final finishes with Owner and review with Consultant, during shop drawing process.
18. Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.

### 1.2 BREAKERS

1. Refer to Section 26 20 00 - Part 1, for general requirements for breakers.

## 2 Products

### 2.1 DISTRIBUTION PANELBOARDS

1. Eaton, "Pow-R-Line" series factory assembled dead front panelboards as per drawing schedules, manufactured to CSA Standard C22.2. No. 29. Generally, interrupting capacities are scheduled, but in absence of direction, provide to capacity to suit intended application and to suit local governing electrical code requirements.
2. Circuit breaker type "PRL4B" distribution panelboards to be single or double row as required and complete with moulded case, bolt-on circuit breakers calibrated for 40°C (104°F) ambient temperature and conforming to CSA Standard C22.2 No. 5 (Note No. 1). Locate both main lugs and neutral bar at same end. Shield main lugs through a removable cover. Identify each circuit breaker adjacent breaker handle. Refer to Part 1 for requirements of breakers to be provided with solid-state adjustable trip units. Group mount circuit breakers.
3. Panelboard interior to have three flat bus bars stacked and aligned vertically with insulators laminated between phases. Insulators support and provide phase isolation to entire length of bus. A solidly bonded equipment ground bar and a neutral bar to be provided.
4. Bus bars (phases, grounds and neutrals) to be hard drawn electrical grade copper, silver plated and extend throughout panel.
5. Interior trim to be of dead-front construction to shield user from energized parts. Main circuit breaker and main lug interiors to be field convertible for top or bottom incoming feed.
6. Panelboard boxes to be constructed of code gauge, hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements, complete with removable ends and wiring gutter space on sides in accordance with CSA requirements.
7. Floor mounted enclosures to be free-standing type, reinforced as required to provide adequate strength.
8. Include main breakers for panelboards as scheduled. Main breakers to be automatic moulded case breakers with solid state trip units as specified in Part 1 article.
9. Enclosures located in climate-controlled areas to be minimum NEMA 1 or NEMA 2. Surface mounted panelboards to be complete with drip shield. Ventilation louvres to be designed to prevent penetration of water spray onto live components. Conduit entries to be sealed watertight. Units to be factory painted in ANSI grey enamel. Recessed backboxes (tubs) need not be finished painted.
10. Distribution panelboards sized 600 A and less and panelboards not located in secured electrical rooms/closets require doors. Panelboards sized up to 600A and panelboards located in unsecure areas to be complete with doors, latches, and keyed alike locks. Locks to be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. Supply minimum 2 keys with each lock.
11. Panelboards to include for future breaker provisions as noted on schedules. Make provision for space for breakers, bussing for full panel size and where spare breakers are scheduled, breakers with required connector kits. Unused spaces provided, unless otherwise specified, to be fully equipped for future devices, including appropriate connectors and mounting hardware.



12. Panelboards as scheduled to be complete with integral surge protective devices (SPDs). Unit to be factory installed and connected onto bussing through integral disconnect/ breaker as recommended by manufacturer. Unit to include diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts. Unit to be maintenance free. Refer to Section 26 43 00 for additional SPD requirements for distribution panelboards.
13. Acceptable Manufacturers:
  1. Eaton.
  2. Schneider Electric (I-Line Series).
  3. Siemens Electric Ltd.

### **3 Execution**

#### **3.1 INSTALLATION OF DISTRIBUTION PANELBOARDS**

1. Provide distribution panelboards and install into locations and connect complete. Install panelboards with adequate clearance as per code requirements and as required for access for operation and maintenance.
2. Install floor mounted panelboards on concrete housekeeping pads. Provide seismic restraints as required by local governing authorities and codes. Surface wall mount other panelboards, unless otherwise noted, independent of connecting conduit.
3. Equip each panelboard with suitable lugs to accommodate main and branch conductors as scheduled. Identify panelboard and breakers with Lamacoid identification nameplate with nomenclature approved by Owner and reviewed with Consultant.
4. Connect SPD in accordance with manufacturer's instructions and with dedicated breaker.
5. Ground and bond equipment as per local governing electrical code and inspection authority requirements. Refer also to requirements of grounding and bonding article.
6. Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements. Document test results and submit copy to Consultant.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.

### 1.2 BREAKERS

1. Refer to Section 26 20 00 - Part 1, for general requirements for breakers.

## 2 Products

### 2.1 BRANCH CIRCUIT PANELBOARDS

1. Eaton "Pow-R-Line" series, factory assembled dead front panelboards as per schedules, manufactured to CSA Standard C22.2 No. 29 and local governing electrical code, and designed for sequence phase connection of branch circuit breakers.
2. As scheduled, panelboards are of types:
  1. For panels with main breaker or main lugs up to 225 A, 120/208 V: "Pow-R-Line 1", 3-phase and single phase with minimum "BAB" frame, bolt-on moulded case circuit breakers with a minimum interrupting capacity of 10 KA symmetrical at 208 V, unless otherwise scheduled. Where panelboards are schedule to include series rated provisions, provide breakers as recommended by panel manufacturer.
  2. For panels with main breaker or main lugs up to 225 A, 347/600 V: "Pow-R-Line 2", 3-phase panelboards with bolt-on moulded case circuit breakers with interrupting capacity as scheduled or in absence of direction to be of capacity for intended application to local governing electrical code requirements.
  3. For panels with main breaker or main lugs 400 A to 600 A, 120/208 V and 347/600 V: "Pow-R-Line 3", 3-phase panelboards with bolt-on moulded case circuit breakers with interrupting capacity as scheduled or in absence of direction to be of capacity for intended application to local governing electrical code requirements.
3. Where ground fault circuit interrupting (GFCI) type breakers are required by code and/or scheduled, provide "Quicklag" ground fault, CSA Class "A", Group 1, combination thermal magnetic bolt-on circuit breakers with solid-state ground fault interrupters.
4. Panelboards to be equipped with one (1) continuous bus bar per phase. Each bus bar to have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. Bussing to be fully rated and of plated copper construction.
5. Panelboards are to be complete with:
  1. NEMA 1 or NEMA 2 box, constructed of code gauge galvanized steel with removable box ends, wiring gutter space on sides; conduit entries sealed water-tight; drip shield for surface mounted panelboards;
  2. dead-front construction to shield user from energized parts;
  3. enclosure constructed of code gauge, hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements; trim for flush or surface wall mounting as shown; front panel to not be removable with the door locked;
  4. hinged door with concealed fasteners, concealed hinge, chrome plated door latch and keyed alike lock with key;
  5. steel frame holder and circuit directory card protected by clear acetate and secured to back of door, and Mylar circuit breaker identification strips;
  6. copper neutral bars;
  7. 200% sized neutrals for panels equipped with SPD units and for panels as scheduled;
  8. solidly bonded equipment copper ground bar;
  9. high strength, set screw type, anti-turning wire connectors;
  10. current-carrying parts be insulated from ground and phase-to-phase by high dielectric strength thermoplastic;

11. isolated ground bus for panelboards feeding electrically sensitive equipment;
  12. filler plates covering unused mounting space;
  13. non-automatic and automatic main breaker to function as an isolating switch, where shown and as required;
  14. ground fault circuit interrupting (GFCI) type breakers to feed devices as scheduled and for applications required by local governing codes;
  15. arc fault circuit interrupter (AFCI) type breakers to feed devices as scheduled and for applications required by local governing codes.
6. Panels, doors and trim are to be factory painted with ANSI grey enamel finish. Recessed backboxes (tubs) need not be finished painted.
  7. Equip breakers of frame size 225 amperes and greater, with solid state adjustable trip units.
  8. Equip circuit breakers connected to dedicated equipment or devices with handle locks.
  9. Panelboards as scheduled to be complete with integral surge protective devices (SPDs). Unit to be factory installed and connected onto bussing through integral disconnect/breaker as recommended by manufacturer. Unit to include diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts. Unit to be maintenance free.
  10. Refer to Section 26 43 00 for additional SPD requirements for branch circuit panelboards.
  11. Include spare breakers as sized on schedules and future breaker provisions as noted on schedules. Future breaker provisions to include space for breakers, bussing for full panel size and where future breaker sizes are scheduled, required breaker connector kits.
  12. Acceptable Manufacturers:
    1. Eaton.
    2. Schneider Electric (Square D).
    3. Siemens Electric Ltd.

### 3 Execution

#### 3.1 INSTALLATION OF PANELBOARDS

1. Provide factory assembled branch circuit panelboards and install into locations and connect complete. Install panelboards with adequate clearance as per code requirements and as required for access for operation and maintenance. Load panels with breakers as scheduled and as required.
2. Support cabinets and enclosures independent of connecting conduit, and accurately install with reference to wall finishes.
3. Equip panelboards with suitable lugs or provisions to accommodate main and branch conductors scheduled.
4. Coordinate with Mechanical Division trades and Consultant to determine extra mechanical loads and BAS panels requiring use of specified additional 15A circuits and connect complete.
5. Ground and bond equipment as per local governing electrical code and inspection authority requirements. Refer also requirements of Section entitled – Grounding and Bonding.
6. Turn over to Consultant, prior to application for a Certificate of Substantial Performance of Work, minimum quantity of two panelboard cabinet or enclosure keys per panelboard.
7. Where two or more panelboards are installed in one cabinet, equip panelboards with double lugs and increase gutter capacity to accommodate additional cabling.
8. Identify panelboard breakers in a permanent manner, and complete typed panelboard circuit directories identifying circuit number and type and location of loads supplied from each breaker with nomenclature approved by Owner and reviewed with Consultant.

9. Include for spaces for future breakers, spare breakers and additional breakers for miscellaneous mechanical loads are included as per schedules and as specified.
10. Install and connect SPD in accordance with manufacturer's instructions and with dedicated breaker. Test SPD as per manufacturer's instructions.
11. Test and verify ground fault circuit interrupting breakers as follows:
  1. demonstrate in presence of Consultant that protected circuits will "trip" when a simulated ground fault is applied to "load" side of each circuit breaker/ground fault interrupter combination;
  2. megger load side neutral on GFCI protected branch circuits to ensure that neutral is not grounded on load side of GFCI;
  3. verify GFCI operation with governing authority approved GFCI tester suitable for application;
  4. provide a written report confirming that tests have been performed and that system is functioning properly.
12. Test and verify arc fault circuit interrupting breakers as per manufacturer's instructions.
13. Ground and bond panel as per local electrical code requirements. Refer also to requirements of grounding and bonding article.
14. Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements. Document test results and submit copy to Consultant.

**END OF SECTION**

## **1 General**

### **1.1 SUBMITTALS**

1. Submit shop drawings for products specified in this Section.

## **2 Products**

### **2.1 UTILITY METERING**

1. Type NEMA 3R weatherproof enclosure, 4 jaw meter base with maximum 200A, 600V ratings, Peerless meter seal rings and manufactured to CSA C22.2.
2. Confirm exact model number with local governing electrical utility.
3. Acceptable manufacturers are Microelectric and Eaton.
4. Provide conduit and fish cord in accordance to requirements of local electrical utility.

### **2.2 UTILITY METERING CABINETS**

1. Surface wall mounting, NEMA 2, with sprinklerproof provisions, enamelled steel meter cabinets complete with gasketing, and padlocking provisions, in accordance with local governing electrical utility requirements. Cabinet to be approved by local governing electrical utility.
2. Provide conduit and fish cord in accordance to requirements of local governing electrical utility.

## **3 Execution**

### **3.1 INSTALLATION OF METERING PROVISIONS**

1. Install meter enclosure with base and accessories in accordance with manufacturer's instructions and as per local electrical utility's requirements. Connect complete.
2. Coordinate and arrange for local governing electrical utility's incoming service work.
3. Obtain required inspections, approvals and certificates.

### **3.2 INSTALLATION OF UTILITY'S METERING CABINETS**

1. Provide approved metering cabinets and conduit and install in accordance with local governing electrical utility requirements. Install cabinet in locations and install into locations and connect complete. Provide adequate clearance around cabinet as per code requirements and as required for access for operation and maintenance. Provide required supporting hardware. Extend empty conduit from cabinets to metering compartments of switchboard or to main disconnect or to meter base as required.
2. Coordinate installation with local governing electrical utility that will install meter equipment, and connect from meters to metering compartments of switchboard or to meter base. Confirm exact location of metering cabinet with local governing electrical utility and review with Consultant.

### **3.3 TRAINING**

1. Manufacturer's trained technician to perform onsite training of each user (including the provision of user guides) prior to project completion to ensure that users are properly trained in the operation and maintenances of system.
2. Refer to Instructions to Owner specified in Section entitled Electrical Work General Instructions.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.
2. Submit samples of each typical wiring device, faceplates, finishes and colours. Mount to sample board, clearly labelling devices and finishes. Submit for review with Consultant. Do not order any device unless finishes have been approved by Owner and reviewed with Consultant.

## 2 Products

### 2.1 SWITCHES

1. Switches to be CSA approved, ULC listed and labelled devices.
2. Hubbell Canada Inc., HBL 1221 Series, CSA approved, heavy duty, industrial grade, back, and side wired, AC quiet action toggle type, 20 ampere, 120-277 V switches. Switches to include steel-nickel plated bridge, nylon toggle, one-piece rivetless copper alloy spring contact arm and terminal plate, silver cadmium oxide contacts, brass binding head screws, one-piece integral grounding terminal and stainless-steel automatic grounding clips. Provide single way, 2-way, 3-way, and key type to suit specific application requirements.
3. Hubbell Canada Inc., HBL 181221CN Series, CSA approved, extra heavy duty, industrial grade, back and side wired, AC quiet action toggle type, 20 ampere, 347 V switches. Switches to include steel-nickel plated bridge, nylon toggle, one-piece rivetless copper alloy spring contact arm and terminal plate, silver cadmium oxide contacts, brass binding head screws, one-piece integral grounding terminal and stainless-steel automatic grounding clips.
4. Acceptable manufacturers are:
  1. Hubbell Canada Inc.;
  2. Eaton - Cooper Wiring Devices (Arrow Hart);
  3. Legrand - Pass & Seymour;
  4. Leviton.

### 2.2 RECEPTACLES

1. Receptacles to be CSA approved, ULC listed, certified and labelled devices.
2. Hubbell Canada Inc., No. HBL5262 / HBL5362 CSA approved, ULC listed, extra heavy duty, specification grade, back and side wired, flush, nylon face/body construction, duplex U-ground, 15/20 ampere, 125 V, 2-pole, 3-wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.
3. Hubbell Canada, No. GFR 5262SG / GFR 5362SG "AUTOGUARD" Series, extra heavy-duty grade, 15/20 ampere, 125 V, duplex, ULC Class "A", Group One, tamper resistant, weather resistant ground fault circuit interrupting receptacles complete with automatic self-test diagnostics, green power ON LED, red ground fault LED and 10ka short circuit current rating.
4. Hubbell Canada Inc., No. 9430, EEMAC type 14-30R, 30 ampere, 125/250 V, 3-pole, 4-wire single electric clothes dryer receptacles with steel faceplates.
5. Hubbell Canada Inc., No. 9450, EEMAC type 14-50R, 50 ampere, 125/250 V, 3-pole, 4-wire single electric range receptacles with steel faceplates.
6. Hubbell Canada, No. 15 ampere and 50 ampere receptacles complete with neutral and ground conductors required for indicated number of phases as required.
7. Where noted that 20 A receptacles are required, include for "T" slot type of respective series of receptacles.

8. Colour of special switches and receptacles (unless specified above), to be as specified in PART 3 of this Section of Specification.
9. Special switches and receptacles not specified above are to be specified on drawings. Low voltage lighting controls are specified in Section entitled Lighting Control.
10. Acceptable manufacturers are:
  1. Hubbell Canada Inc.;
  2. Eaton - Cooper Wiring Devices (Arrow Hart);
  3. Legrand - Pass & Seymour;
  4. Leviton.

### 2.3 FACEPLATES

1. Grade 18 8, type 430, 1 mm (0.032") thick stainless steel, satin, brushed or natural finish, complete with a peel off protective plastic film, and stainless steel screws.
2. Hubbell Canada Inc., No. WP8E / WP8EH, NEMA 3R rated, CSA approved, ULC listed and labelled, single gang, vertical/horizontal mounting, weather-proof in-use, gasketed, cast aluminium faceplates for standard duplex receptacles in wet locations.
3. Hubbell Canada Inc., No. WP26E/WP26EH, NEMA 3R rated, CSA approved, ULC listed and labelled, single gang, vertical/horizontal mounting, weather-proof in-use, gasketed, cast aluminium faceplates for GFI receptacles in wet locations.
4. Galvanized steel stamped faceplates.
5. Hubbell Canada Inc., forged brass "S" Series faceplates with flip open doors for receptacles.
6. Colours and finishes of faceplates are specified in Part 3 of this Section.
7. Acceptable manufacturers are as per switches and receptacles.

## 3 Execution

### 3.1 INSTALLATION OF SWITCHES

1. Provide devices and install in electrical outlet boxes. Refer to drawings to determine flush or surface mounting requirements. Generally, flush mount devices in finished areas. Size electrical boxes to suit device requirements as per device manufacturer's recommendations. Properly ground device to box and ground system as per code requirements and manufacturer's instructions.
2. For pricing only, switches to be ivory for devices connected to normal power circuits, red for devices connected to essential power circuits.
3. Every switch connected to essential (emergency) power circuits, to be illuminated toggle type.
4. Illuminated operation of lighted switches to suit specific applications as confirmed with Consultant.
5. Ensure that switches located adjacent to doors are located at strike side of door. Confirm door swing requirements on architectural drawings, not on electrical drawings.
6. Coordinate installation of door switches with trades responsible for provision of doors and frames. Review exact locations of switches with Consultant to ensure optimum operation of switch to door position.
7. Review final device finishes with Consultant as per sample board submission specified in Part 1. Do not order any devices unless final finishes have been approved by Owner and reviewed with Consultant.
8. Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

### 3.2 INSTALLATION OF RECEPTACLES

1. Provide devices and install in electrical outlet boxes. Refer to drawings to determine flush or surface mounting requirements. Generally, flush mount devices in finished areas. Size electrical boxes to suit device requirements as per device manufacturer's recommendations. Properly ground device to box and ground system as per code requirements and manufacturer's instructions.
2. For pricing only, receptacles to be ivory for devices connected to normal power circuits, red for devices connected to essential power circuits.
3. Install exterior receptacles in accordance with drawing details, and as coordinated and reviewed with Consultant. Comply with local governing electrical code with regards to wiring and installation requirements. Properly ground installations.
4. Provide typed label identifying circuit number and panelboard from where each device is fed, permanently identified at outlets. Review exact location for identification with Consultant.
5. Where receptacles are indicated in counters and benches, box cut-out to be provided in counter and bench. Provide a box, receptacle, plate and branch circuit wiring. Branch circuit wiring within counters and benches to be flexible armoured cable, under requirements of local governing electrical code and standards. Install and connect complete.
6. Review locations and nomenclature of nameplates and labelling with Consultant prior to printing of labels and nameplates. Turn over label maker to Consultant/Owner prior to application for Certificate of Substantial Performance of the Work.
7. Review final device finishes with Consultant as per sample board submission specified in Part 1. Do not order any devices unless final finishes have been approved by Owner and reviewed with Consultant.
8. Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

### 3.3 INSTALLATION OF FACEPLATES

1. Provide each device with a faceplate with an opening or openings suitable for device it conceals and covers openings around boxes. Secure faceplates to device frames with screws to match faceplates. Provide larger than standard type faceplates for devices that require engraved nomenclature to define special purpose for that device.
2. Provide nylon type standard size faceplates for flush mounted devices.
3. Provide stainless steel type standard size faceplates for flush mounted devices.
4. Provide galvanized stamped steel faceplates in service areas and equipment rooms where devices are surface mounted.
5. Isolated ground receptacles connected to circuits fed from uninterruptible power supply units to be equipped with faceplates in orange colour.
6. Provide faceplates for computer equipment isolated ground receptacles with label printed with "Computer Equipment Only" lettering.
7. Provide faceplates for housekeeping receptacles with label printed with "Housekeeping Only" lettering.
8. Provide weatherproof insulated faceplates with hinged and gasketed receptacle access flaps for weatherproof receptacles denoted "WP" on drawings.
9. Generally, oversized faceplates to be provided where engraved lettering is required.
10. Faceplates for flush floor mounted receptacles in standard floor boxes to be forged brass rectangular faceplates.



11. For flush mounted devices, provide oversized faceplates as required to properly cover wall openings around recessed boxes.
12. Provide faceplates with suitable identification labels. Review exact locations for labelling with Consultant.
13. In addition to identification requirements specified with devices, provide faceplates with printed self-adhesive label on inside face identifying circuit number and panel feeding device. Turn over label maker to Consultant prior to application for Certificate of Substantial Performance of the Work.
14. Review exact material, finish, and colour of faceplates for devices in any particular area with Consultant prior to ordering. Submit sample board as per requirements of Part 1.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.
2. Submit samples of each device and colour finishes.

## 2 Products

### 2.1 FLOOR BOXES AND SERVICE FITTINGS

1. Legrand Wiremold "Resource RFB4E" multi-service series, CSA approved, flush floor box as follows:
  1. 4-independent wiring compartments that allow capacity up to 4 duplex power receptacles and/or communication brackets for telecommunications services;
  2. steel construction;
  3. cast iron version suitable for on-grade applications;
  4. steel version suitable for above grade applications;
  5. suitable for concrete and wood floor installations, as required;
  6. fully adjustable before and after concrete pour;
  7. knockouts sized from 20 mm (3/4") to 50 mm (2") dia;
  8. approximately 334 mm L x 334 mm W x 103 mm D (13-1/8" x 13-1/8" x 4-1/16");
  9. knockouts sized from 20 mm to 50 mm (3/4" to 2");
  10. tunnelling from compartments as required;
  11. mounting brackets for power receptacles and communication modular devices; note that depth to suit floor slab restrictions as directed by Consultant;
  12. series "Evolution" activation cover consisting of 184 mm (7-1/4") diameter, round, flush access cover opening a full 180 degrees to lie flat on the floor; cover includes two smaller slide open cable egress doors; complete with trim rings; die cast aluminum construction; exact finish and floor type to be reviewed with Consultant prior to ordering;
  13. unit designed to prevent water and debris from entering box as per requirements of UL 514A and UL 514 C.
2. Legrand Wiremold "Evolution" series, CSA approved, ULC listed and labelled, flush floor boxes as follows:
  1. configurable with removable modules and dividers for from 6 to 10 gangs, as required;
  2. versions suitable for installations in concrete, raised floors and wood floors, as required;
  3. 2 module wiring compartments with multi-gang capacity for duplex power receptacles and/or communication brackets for telecommunications services;
  4. steel construction;
  5. levelling support legs fully adjustable pre and post concrete pour;
  6. approximately 384 mm L x 284 mm W x 103 mm D (15-1/8" x 11-3/16" x 4-1/16");
  7. tunnelling from compartments as required;
  8. mounting brackets for power receptacles and communication modular devices;
  9. activation cover consisting of large hinged rectangular access cover opening a full 180 degrees to lie flat on the floor; cover includes two smaller slide open cable egress doors; complete with self-closing recessed handle, trim rings and flooring insert areas; die cast aluminium construction of finish reviewed with Consultant; flooring type to be reviewed with Consultant;
  10. knockouts sized from 20 mm to 50 mm (3/4" to 2");
  11. unit designed to prevent water and debris from entering box as per requirements of UL 514A and UL 514 C.
3. Finishes to be as approved by Owner and reviewed with Consultant.

4. Refer to drawing details and notes for additional device requirements. Provide power receptacles to standards as specified in wiring devices article. Coordinate telecommunication jack types and installation requirements with telecommunications structured cabling system contractor responsible for work of structured cabling systems. Ensure that brackets are compatible with devices.
5. Acceptable manufacturers are:
  1. Legrand Wiremold;
  2. Hubbell Canada Inc.;
  3. Thomas & Betts Ltd.;
  4. Wellmark Electric.

## 2.2 ACCESS FLOOR SERVICE BOXES

1. Tate Access Floors Inc., "PVD Servicecenter" series, CSA approved, flush access floor box as follows:
  1. 2-independent wiring compartments that allow capacity of two duplex power receptacles and two communications mounting plates;
  2. standard floor height and standard capacity;
  3. approximately 185 mm L x 175mm W x 142mm D (7-1/2" x 7" x 5-3/4");
  4. conduit knockouts for field wiring;
  5. faceplates and mounting brackets for power and communication devices;
  6. floor port activation cover consisting of swing open and removable covers with provisions to prevent water and debris from entering box as per requirements of UL, complete with die cast aluminium trim and flooring insert areas;
  7. final finishes as approved by Owner and reviewed with Consultant.
2. Refer to drawing details and notes for additional device requirements. Provide duplex receptacles to standards as specified in wiring devices article. Refer to drawing details and notes for device requirements. Coordinate telecommunication jack types and installation requirements with telecommunications structured cabling system contractor responsible for work of structured cabling systems.
3. Acceptable manufacturers are:
  1. Tate Access Floors Inc.;
  2. Legrand Wiremold;
  3. Camino Modular Systems.

## 3 Execution

### 3.1 INSTALLATION OF FLOOR BOXES AND SERVICE FITTINGS

1. Prior to start of Work, review with Consultant, conduit runs for each service floor box - whether conduits run within floor slab or connect to boxes through floor slab from floor below.
2. Provide type of boxes to suit applications as required for on-grade floors, above grade floors, and concrete or wooded floors.
3. Review finishes and cover inserts where applicable, with Consultant prior to ordering.
4. Provide flush floor boxes in concrete slab locations. Adjust and level as required. Level flush boxes before concrete pour. Provide conduits to connect to boxes as required.
5. Do not install non-metallic type boxes in on-grade floor slabs.
6. Review with Structural Consultant that size of boxes and depth of selected floor boxes is acceptable for installation in floor of installation. Advise Consultant of any concerns.
7. Where fittings are surface mounted on counters, coordinate installation with trade responsible for counters. Review exact location of openings prior to cutting openings. Install conductors to feed fitting outlets and connect complete.

8. Provide required outlet fittings and install on recessed boxes. Provide required wiring in conduit and connect complete.
9. Install products in accordance with manufacturer's requirements. Coordinate work with trade pouring or cutting floor slab.
10. Coordinate mounting requirements for telecommunication type jacks with trade responsible for provision of respective telecommunication systems.
11. Ground and bond boxes to local governing electrical code requirements.
12. Test assembly to verify proper operation.

### **3.2 INSTALLATION OF ACCESS FLOOR BOXES IN RAISED FLOOR SYSTEMS**

1. Provide flush floor boxes in raised access floors locations. Review floor height and ensure that height is suitable for selected boxes. Advise Consultant of any concerns with regards to installation. Adjust as required. Ensure that floor tile opening is sized to suit floor box assembly. Where openings need to be cut, coordinate work with Subcontractor installing floor system or with General Trades Contractor.
2. Obtain required training from manufacturer's representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.
3. Provide required outlet fittings and install on boxes. Install devices in accordance with manufacturer's requirements. Provide required wiring in conduit and connect complete.
4. Coordinate mounting requirements for telecommunication type jacks with trade responsible for provision of respective telecommunication systems.
5. Review finishes and cover inserts where applicable, with Consultant prior to ordering.
6. Ground and bond boxes to local governing electrical code requirements.
7. Test assembly to verify proper operation.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.

### 1.2 REFERENCE STANDARDS

1. Electric vehicle (EV) charging systems to be designed, manufactured and tested according to latest applicable version of following standards:
  1. cUL listed and labelled and CSA approved;
  2. CSA C22.2 No. 280;
  3. CSA C22.2 Nos. 281.1, 281.2 and 282.13;
  4. UL 2594, UL 2231-1, UL-2231-2. UL 1998;
  5. SAE J1772;
  6. FCC: Part 15 Declaration of Conformity and Part 15 Class A.

### 1.3 QUALITY ASSURANCE

1. Manufacturer to have produced similar electrical equipment for minimum period of 3 years.
2. Products to comply with above related standards.

## 2 Products

### 2.1 ELECTRIC VEHICLE CHARGING STATIONS

1. Stations to be based on Leviton "evr-green e40" series, Level 2 electric vehicle charging stations as located on drawings. Refer to drawings for details regarding location of components, mounting requirements, electrical ratings and other required details.
2. Station features include:
  1. NEMA Type 3R, compact size, water-resistant, thermoplastic and vandal-proof enclosure;
  2. "Auto-Reclosure" feature enables charging to restart following minor fault, thereby reducing chance of having undercharged battery;
  3. Ground monitor interrupter circuit for safety;
  4. Integrated On/Of switch to minimize standby power;
  5. Status LED indicator lights;
  6. Electrical Input: 40A;
  7. Electrical Output Power: 9.6kW (40A@240V);
  8. Charging Connector: SAE J1772, NEMA Type 3S connector on 7.62 m (25') long UL Type EV cable, with locking feature;
  9. Operating Temperature: -30°C to +50°C (-22°F to +122°F).
3. Miscellaneous:
  1. Lamacoid - custom inscribed identification instruction signage with nomenclature as confirmed with Owner and reviewed with Consultant;
  2. Mounting hardware and accessories to suit installation requirements of units. Refer to drawings;
  3. Heavy duty impact resistant thermoplastic cable management hook with mounting hardware to suit installation;
  4. Pedestal Mounting Pole and Base: accommodate up to 2 charging stations enabling charging for two parking spots; with charge connector docking bracket and stainless steel hardware; constructed of durable powder coated steel with weather-resistant and corrosion resistant finish; of finish colour and height confirmed with Owner and reviewed with Consultant;

5. Demonstration and Training: Provide services of manufacturer's authorized representative to provide start up service and to demonstrate and train Owner's personnel on procedures and schedules related to start up and shutdown, troubleshooting, servicing, and preventive maintenance;
6. Warranty: Equipment manufacturer to warrant that goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation.
4. Acceptable Manufacturers:
  1. Acceptable manufacturers include base specified Leviton.
  2. Other manufacturers may be accepted at discretion of and approval by Owner, and subject to following (submit proof with shop drawings):
    1. that system features and performance at least match base specified system;
    2. systems are CSA approved and ULC listed and labelled, as applicable;
    3. system has been installed and operating in other Canadian facilities for at least past three (3) years;
    4. system products and parts are stocked and serviced by Canadian distributor/vendor within Province of install.

### **3 Execution**

#### **3.1 INSTALLATION OF EV CHARGING STATIONS**

1. Obtain required approvals and permits of local governing authorities and electrical inspection authorities.
2. Installation work to be performed by qualified person familiar and experienced with installation, construction and operation of equipment and hazards involved.
3. Install per manufacturer's recommendations and contract documents, including drawing notes and details. Comply with requirements of local governing building codes and electrical codes.
4. Review installation locations and mounting requirements with Consultant prior to roughing-in. Co-ordinate with other trades as required.
5. Install units plumb, level and rigid without distortion. Secure with required mounting hardware to suit installation application.
6. General installation of stations to follow procedure in manufacturers' published literature.
7. Provide required power and communications conductors in conduit and connections. Coordinate communications interconnections with Owner's personnel. Connect to dedicated non-GFCI type circuit breaker as per charger manufacturer's directions.
8. Do not make any changes or modifications to product not authorized by manufacturer.
9. Interconnect ground with main building grounding.
10. Provide signage with nomenclature approved by Owner and reviewed with Consultant. Secure in locations as reviewed with Consultant.

#### **3.2 ADJUSTMENTS AND CLEANING**

1. Remove debris from e electric vehicle charging station and wipe dust and dirt from components.
2. Repaint marred and scratched surfaces with touch up paint to match original finish.

#### **3.3 TESTING**

1. Check and inspect component connections and overall installation.
2. Check tightness of accessible mechanical and electrical connections to assure they are torqued to minimum acceptable manufacturer's recommendations.

3. Check installation for proper grounding, fastening and alignment.
4. Check communications between equipment and integrated systems, as applicable.
5. Obtain required approval and certifications of local governing authorities. Submit copies of approvals to Consultant.

**END OF SECTION**

## **1 General**

### **1.1 SUBMITTALS**

1. Submit shop drawings for products specified in this Section, including but not be limited to following:
  1. engine generator set (genset) with accessories;
  2. genset control panel and related controls;
  3. integration drawings identifying various integration points of other systems of building;
  4. certification that proposed gensets have been prototype tested as fully integrated assembly at vendors factory and is CSA approved.
2. Include following with shop drawings:
  1. full design detail drawings and layouts;
  2. wiring schematics;
  3. dimensions and weight of set and associated major components;
  4. electrical characteristics;
  5. power and performance data;
  6. fuel consumption data;
  7. point by point description of control system software sequence of operation;
  8. nameplate data identifying electrical characteristics;
  9. list of manufacturer-recommended spare parts, devices and equipment to be provided to Owner and to be kept at site in order to minimize risk and to facilitate Owner's maintenance program.

### **1.2 STANDARDS**

1. Gensets and associated equipment to be CSA approved with certificate of compliance, and constructed to and to perform in accordance with following requirements:
  1. CSA C282-15 Emergency Electrical Power Supply for Buildings including maintenance logbook;
  2. CSA Standard Z32-15 Electrical Safety, and Essential Electrical Systems in Health Care Facilities;
  3. CSA B139-15 Installation Code for Oil-Burning Equipment;
  4. CSA C22.1-15 Canadian Electrical Code, Part I and Ontario Electrical Safety Code 26th Edition/ 2015;
  5. CSA C22.2 No. 100-04 (R2013) Motors and Generators;
  6. CAN3-C235-83 (R2015) Preferred Voltage Levels for AC systems, 0 to 50,000 V.
2. Genset manufacturer to be certified to ISO 9001 International Quality Standard and have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

### **1.3 TYPICAL DETAILS**

1. Refer to typical details found on drawings for references to products and/or execution required in this Section.

### **1.4 WARRANTY**

1. Warrant (full 100% parts and labour with no deductible amounts) gensets and control system equipment in writing, to be in strict accordance with Specification and free from defects for 1 year from date of turn over to Owner. Warranty period starts after acceptance tests and subsequent written acceptance by Consultant and after full connection to building load.
2. Include for manufacturer/supplier's authorized technician 24 hours around clock service for onsite genset and equipment.



3. Include with warranty, following:
  1. first year routine maintenance service including parts and labour;
  2. complete oil and filter changes at manufacturer's recommended intervals to maintain warranty validity;
  3. manufacturer's recommended maintenance and servicing to maintain validity of warranty;

## 1.5 NOISE AND EMISSIONS

1. Genset to be provided in compliance with O.Reg 524/98 necessary technical data (environmental, noise and emissions and performance), such that genset and installation on this project is exempt from requirements in obtaining required approvals and/or certifications from and/or registration with Ministry of Environment – Climate Change – Environment Activity and Sector Registry (MOECC EASR) for generator registration.
2. Provide Owner approved emissions specialist company to obtain required approvals and/or certifications from and/or registration with Ministry of Environment – Climate Change – Environment Activity and Sector Registry (MOECC EASR) for generator registration. Obtain and necessary technical data.
3. Provide genset and work that maintains compliance with levels of noise and air emissions approved by local authorities having jurisdiction.

## 2 Products

### 2.1 ENGINE GENERATOR SETS-GENERAL

1. Engine generator sets (gensets) to be factory assembled and tested, radiator cooled, diesel engine driven electric gensets including necessary controls and accessories as outlined herein, to comprise a continuous, standby electric generating plant for operation in conditions stipulated below. Gensets to be equipped with necessary operating accessories such as air cleaner, radiator fan, lubricating oil pump, governor, alternating current generator and other specified and required engine driven components and accessories.
2. Genset manufacturer to be certified to ISO 9001 International Quality Standard and have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
3. Gensets to include prototype testing as follows:
  1. Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  2. NFPA 110, Level 1. Equipment engine, skid, cooling system, and alternator to have been subjected to actual prototype tests to validate capability of design under abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.
4. Base design gensets: Cummins ONAN packaged model SD500, genset that complies with specification requirements and drawing requirements and which may be customized to meet herein specified requirements.
5. Gensets and associated equipment to be constructed to and to perform in accordance with local governing authority enforced edition of CSA Standard CAN/CSA C282, "Emergency Electrical Power Supply of Buildings". Gensets to be CSA approved type tested in vendor's plant.
6. Where requirements of preceding standards and specification are in variance, more stringent requirement is to apply unless otherwise approved by Owner and reviewed with Consultant.
7. Genset emissions to meet required EPA exhaust Tier limits based upon engine maximum horsepower rating and any other required Ministry of Environment regulations, and requirements noted above.

8. Gensets and associated equipment to comply with mechanical systems base design parameters (ie. fuel consumption, cooling operating data, air/exhaust operating data, etc.) to ensure that design minimum standards and performance criteria for units are met. Review room/enclosure (as applicable) dimension and layouts and ensure that proposed gensets and associated equipment can be accommodated and also allow for sufficient space for maintenance, repairs, and safety as per applicable code requirements. Advise Consultant of any changes due to manufacturer's changes in equipment, and/or changes in manufacturers. Be fully responsible for provision and co-ordination of a designed solution that can meet design intent, space limitations, and performance requirements with no additional costs to Contract. Co-ordinate changes with Mechanical Division, as required.
9. Genset driven radiator fan is capable of overcoming a minimum of 0.5" water column pressure drop in an ambient temperature of 50°C (122°F). Review complete air intake and exhaust system design with regards to air restrictions and if required, provide oversized fans with blades of extra strength to overcome additional pressure drop through fresh air intake, discharge silencers, and other related factors, as applicable. Identify clearly on shop drawings that this requirement has been met.
10. Where eventual supplied genset(s) provides performances that are different from base designed genset, and such differences exist only due to differences in product manufacturers, be responsible for providing required revisions, i.e. increasing sizing of exhaust piping, air dampers, etc. At shop drawing submission stage, submit detailed genset performance data to Mechanical Division Contractor to confirm mechanical equipment sizing and to make necessary revisions. Be responsible for costs for such revisions.
11. Genset ratings:
  1. Rating of engine generator is as noted on drawings, which is at 0.8 power factor and includes 10% overload.
  2. Rating to be nameplate rating.
  3. Capable of operating at 100% of nameplate rating at rated RPM in an ambient temperature of 50°C (122°F) without overheating, or suffering any other detrimental effects, at rated generator RPM when set is equipped with all necessary operating accessories.
  4. Capable of handling a single full load step for nameplate kilowatt rating within voltage and frequency regulation requirements of CSA 282 without stalling and without voltage dropping below 60% of nominal.
12. Genset to meet frequency and voltage performance requirements specified in CSA 282.
13. Gensets and associated equipment to be fully integrated to comprise a standby power system which automatically functions as follows:
  1. start in event of a commercial power failure;
  2. stop when commercial power has been restored;
  3. be capable of operating at light loads for an extended period of time as normal power failure may occur when only part of full output of genset is required.
14. Moving parts such as flywheels, pulleys, belts, etc., and on manifolds and extending up to and including flexible exhaust pipes, to be enclosed with suitable guards to protect persons from injury. Guards to be easily removable for servicing equipment and are to comply with local governing authority and code requirements.
15. Genset supplier to obtain torsional approval of entire assembly from engine manufacturer. Align and mount genset on a common fabricated steel base of sufficient rigidity to maintain adequate alignment. Genset manufacturer to supply adjustable steel spring vibration isolators. Include also for seismic restraints to comply with local governing authority and code requirements. Provide torsional vibration analysis and critical vibration analysis of genset and submit results to Consultant.

16. Genset manufacturer to review engine exhaust system design and confirm in writing that back pressure will not impair operation and output of sets. Forward a copy of confirmation letter to Consultant.
17. Genset supplier is responsible for but not limited to provide following:
  1. genset(s) and control panels;
  2. enclosure, as applicable;
  3. fully integrated synchronizing and paralleling control panels, as applicable;
  4. where applicable, modifications to existing genset to allow for integrated synchronization and paralleling, unless otherwise noted;
  5. system sequence of operation complete with software;
  6. coordination with other trades and systems to ensure proper integration;
  7. exhaust system silencer and ancillary piping and connectors to engine;
  8. genset and full systems demonstration, testing and verification work;
  9. operating and maintenance instructions.
18. Arrange for genset supplier to review electrical distribution system and ensure that genset grounding provisions are compatible and meet local governing electrical code requirements.

## 2.2 ENGINES

1. Engines to be a multi cylinder, 4-cycle, engine capable of operating at a nominal speed of 1800 RPM when directly connected to generator and free from critical vibrations throughout its entire operation range. Engines to operate satisfactorily on No. 2 diesel fuel and produce specified rated output.
2. Engines to be complete with inter changeable cylinder heads, exhaust valves constructed of special alloy steel, and stellite faced exhaust valve inserts. Lubricating systems to be full pressure oiling type through internally mounted, high capacity, positive displacement type gear pumps with adjustable pressure regulators, lubricating oil cooler and full flow oil filters. Full pressure lubrication to be provided to main bearings, connecting rod bearings and camshaft bearings.
3. Provide drain canisters on air boxes for engines.
4. Equip engines with an electronic governor with speed control and magnetic pick up assembly capable of maintaining speed and voltage regulation within limits previously specified. Electronic governor to be of type recommended by genset manufacturer to provide performance to suit specific application.
5. Equip engines with as required 12/24 volt D.C. electric starting motors, with starting pinion arranged to disengage automatically when respective engine starts.
6. Equip engines with individual safety devices to shut down engine and to sound an alarm in event of conditions specified later in this Section. Provide contacts to pre-alarm for conditions specified later in this Section. Refer to control panel requirements specified elsewhere in this Section and requirements as detailed on drawings for additional requirements. Provide sensors to connect to electronic controls to monitor and display various engine performance characteristics.
7. Filters on air intake to engine are of dry vortex type with replaceable elements.
8. Integral shock isolated mounted emergency lock out stop pushbutton, oil temperature gauge, oil pressure gauge and engine coolant temperature gauge are provided on engine.
9. Engine mounted accessories are readily removable without dismantling engine alternator, or any other accessories.
10. Provide factory installed custom fitted high temperature blanket-type insulation on manifolds and extending up to and including flexible exhaust pipes.

11. Provide "Aeroquip" or equivalent wire braided engine oil extension hoses on oil drain to extend out for easier access. Clip to side of base with proper clips.
12. Provide brass type oil drain valves.
13. Extend oil fill pipe out beyond protection screens to allow for easier access.
14. Provide lube oil level gauge switch on side of oil pan in easily accessible location.
15. Extend fan hub grease fitting out beyond hub housing, for easier service.
16. Pipe engine oil drain out to engine base.

## 2.3 ALTERNATORS

1. Alternator features include following:
  1. voltage rating as noted on drawings;
  2. drip proof, single bearing and close coupled to engine with an SAE housing;
  3. 2/3 pitch;
  4. maximum total harmonic distortion of voltage waveform is not to exceed 6.0% under any given load;
  5. excitation boost not less than three (3) times rated current for 10 seconds;
  6. direct connected brushless exciters; rotating brushless permanent magnet pilot exciter to provide power via automatic voltage regulator to main exciter, and with dynamically balanced rotor permanently aligned to engine by SAE flexible disc coupling;
  7. full amortisseur windings;
  8. windings of Class H rating;
  9. temperature rise not to exceed 130C° as measured by resistance in an ambient temperature 50°C (122°F);
  10. meet or exceed CSA 22.2 No. 100, EEMAC MG 122 and current IEEE Standards;
  11. grounding provisions to suit electrical distribution system.
2. Extension boxes on alternators to be of sufficient size to accommodate "Corflex II" cable and a current sensor for ground fault protection as specified in control panel hereinafter. Connection boxes to be manufactured to isolate "Corflex II" cable specified from set and prevent transmission of vibration. "Corflex II" cables installation to utilize non-ferrous ground bushings. Cable is generally as sized on drawings, but in absence of direction, size conductors in coordination with genset supplier to suit application and local governing electrical code requirements. Alternative cable in conduit arrangements may be proposed for use subject to review with and acceptance by Consultant.
3. Voltage regulation systems are to maintain regulation within limits previously specified and include regulator and manual voltage adjustment potentiometer. Regulator to be a Basler type SR4 or Newage-Stamford no. MX321 or equivalent as recommended by genset manufacturer, static voltage regulator with 3 phase sensing, radio suppression module, frequency choke to prevent damage to voltage regulator in case of lower than nominal engine speed, and adjustable stability circuit.
4. Equipment is designed to minimize Radio Frequency Interference (RFI) under all operating conditions. "Balanced Telephone Influence Factor" (TIF) is not exceed fifty (50).
5. Extend alternator ground out to base.
6. Alternator is equipped with Resistor Temperature Detectors (RTD) type thermistors complete with required relays/contacts as required to send trouble signal to control panel. Control panel to monitor warning signal of high temperature of windings.

## 2.4 ENGINE FUEL SYSTEM

1. Fuel injectors for engine are individual cylinder type, capable of quick replacement. Dual prime fuel filters are complete with receptacle elements, which can be easily removed without disturbing other parts of engine. Where required for proper system performance, genset to be complete with integral mounted auxiliary tank.
2. For each genset provide two (2) fuel oil flexible connectors with braided stainless steel covering, diameter to suit engine requirements and minimum 900 mm (36") long.
3. Fuel lines to be 2 hour rated, flexible braided jacketed, high-pressure lines suitable for use with type of engine fuel, and complete with male swivel fittings.
4. Provide ULC listed, marine type water separator assembly consisting of unit with water sensor complete with gauge, fuel restriction sensor, alarm contacts to send signal to genset control panel, required relays and filter. Provide FM/CSA approved and ULC listed and labelled, shut-off fire safe valves with fusible links.
5. Include interconnected fuel cooler complete with fuel lines, power conductors, control conductors, and ancillary devices as required.
6. Exact type/size/rating and manufacturer of fuel filters, water separators, fuel coolers and associated components to be as recommended by genset manufacturer to suit specific project requirements, and comply with local governing code and authority requirements.

## 2.5 JACKET COOLANT HEATERS

1. Engine jacket coolant heaters to be complete with silicone hoses, immersion type thermostats, pressure switches and ball type-isolating valves on engine water connections. Size of heaters to be sufficient to maintain coolant in engine at genset manufacturer's rated temperature requirements with unit operating at rated loads and conditions (approximately 6 kW, per engine at 208 V, 1-phase, but confirm with genset vendor and revise to suit).
2. Jacket heaters to be automatically disconnected when engines are running via oil pressure switches/engine run relay.
3. Heaters to be KIM "Hotstart" or approved equal, that connect to each engine with high temperature coolant silicone hoses and clamps, specifically used for and approved by governing authorities for such applications.

## 2.6 COOLING SYSTEM

1. Cooling system for engines consists of unit mounted air water radiator system with protective screen and a 50% water/50% ethylene glycol coolant solution.
2. Thermostat maintains coolant temperature at manufacturer's rated temperature with genset operating at rated load. Size radiator to maintain these conditions and provide complete with high performance static pusher fan, fan motors, radiator core guard, duct adapter flange, mounting frame, expansion tank, thermostatic controls, disconnect switch, a suitable open mesh fan guard and shroud.
3. Gate drain brass ball valves are provided for draining coolant from each engine block and radiator. Wire braided hoses, piping and fittings to be silicone and are to extend into drain containment pan under genset.

## 2.7 STARTING SYSTEM

1. Supply a complete starting system for engine, including:
  1. cranking starter motors;
  2. batteries;
  3. battery heater;
  4. battery stand with insulation board;
  5. battery cable;

6. battery chargers;
  7. cranking motor cut-out switch (crank for three (3) attempts with intervening periods during a period of no less than 45 seconds and no more than 75 seconds).
2. Batteries features include:
  1. fully sealed, long life lead acid;
  2. Exide, Delco or Surette with sufficient capacity in an ambient room temperature of 0°C (32°F) to crank each unit at engine manufacturer's recommended cranking starting speed for a period of 60 seconds;
  3. voltage measured at starting motor terminals at end of cranking period specified above, with cranking current flowing, to not be less than 1.75 volts per cell;
  4. sized on basis of engine and battery manufacturer's published data;
  5. type and performance ratings as recommended by genset supplier and approved by Owner and reviewed with Consultant to best meet starting requirements of specified genset.
3. Submit shop drawings and reasons to substantiate choice of batteries.
4. Batteries to be provided on floor standing, corrosion resistant finished, steel rack, complete with following:
  1. manufacturer's recommended maintenance parts and tools;
  2. jumper cables;
  3. mounting bracket for accessories;
  4. plywood base;
  5. PVC tray;
  6. ancillary devices.
5. Battery chargers to be Mechtron, Vulcan Electric Ltd. or approved equal as recommended by genset supplier, with features as follows:
  1. remote wall mounting, totally enclosed enclosure;
  2. fully automatic operation;
  3. operating voltage of 115 volt, 60 cycle AC;
  4. AC switch and overload protection isolating voltage ratio transformer, silicon controlled rectifier assembly and DC protection, all suitable for two (2) rates of charging (trickle charge and high rate of charge for use after engine start);
  5. DC ammeter and DC voltmeter gauges, each with 2% accuracy;
  6. AC power "on" indicating light;
  7. AC power failure alarm;
  8. float voltage adjustment;
  9. equalize circuit;
  10. overload protection;
  11. DC output protection;
  12. maximum charge rate to suit application;
  13. necessary contacts for connection of common alarm signal to control system.
6. Battery chargers to recharge a battery discharged by two cranking cycles (30 seconds each) to 80% of capacity within 4 hours and to full capacity in maximum 12 hours.

## 2.8 ENGINE GENERATOR MOUNTINGS

1. Engine flywheel housing to be connected rigidly to generator housing with SAE adaptor. Unit to be mounted on common, heavy duty, stress relieved, fabricated steel baseplate. Obtain torsional approval report of entire assembly from genset manufacturer and submit copies to Consultant. Report to also outline critical speeds of assembly.
2. Baseplates to be of sufficient rigidity to maintain alignment of engine generator shafts and frames under all conditions during shipping, installation and service and be of all welded construction without bolt on components.

3. Engine generator feet and baseplate sole plates to be machined parallel and true. Shimming to be of steel type and only be permitted underneath generator feet.
4. Baseplate to be supported on suitable type vibration isolators meeting specific applications. Isolation efficiency to not be less than 95%. Provide Kinetics or equivalent Korfund type to suit specific application as per genset manufacturer's recommendations. Typically, isolators to be strategically located in a manner to ensure that each isolator will carry an equal portion of weight and that pressure exerted on structure by each isolator does not exceed 345 kPa (50 psi). Review exact requirements with genset manufacturer and provide vibration isolators and seismic restraints to meet requirements of Specification.
5. Comply with local governing authority and code requirements with regards to applicable seismic restraints. Provide necessary materials and certification by local authority and submit to Consultant.

## 2.9 UNIT MOUNTED CONTROL PANELS

1. Control panels consist of a microprocessor based controller with LCD displays featuring multiple metering displays and graphics, with full options and features as specified herein, and is suitable for operating on system voltage rating noted on drawings, with short circuit capacities to suit maximum short circuit output of alternator.
2. Control panel in enclosure is unit mounted on I-beam support base, vibration isolated from genset, and is complete with monitoring devices, meters, indicators, display, and interconnecting/interfacing devices. Digital metering and displays are mounted at eye level. Control panel enclosure is painted with enamel to match genset finish.
3. Controls and monitoring include but are not be limited to following components:
  1. under frequency/over voltage control module with adjustable relay to trip main breaker on settings of  $\pm 12\%$  of normal;
  2. ammeter  $m \pm 1\%$  accuracy;
  3. voltmeter  $\pm 1\%$  accuracy;
  4. power factor meter;
  5. frequency meter  $\pm 1\%$  accuracy;
  6. elapsed time  $\pm 1\%$  accuracy;
  7. engine gauges for oil temperature, oil pressure and engine coolant temperature;
  8. kW meter  $\pm 1\%$  accuracy;
  9. control system to initiate genset starting and stopping sequence, and annunciate any fault condition (local or remote indication); electronic control module monitors and provides digital display of genset functions; an operator interface alpha numeric display provides for viewing of genset data and provides setup, controls and adjustments; a LED bar graph AC data display or approved equivalent is included;
  10. engine selector switch for "OFF AUTO MANUAL" operation; operation of engine in manual position, when selected, bypasses automatic control system and causes an alarm to occur; switch in "OFF" position causes an alarm to occur; switch in either "OFF" or manual position causes amber indicator lamp identifying "NOT IN AUTO" to illuminate when alarm occurs;
  11. alarm horn with silencing button, and an annunciator to flash when any audible alarm is silenced until trouble has been cleared and reset;
  12. miscellaneous controls as shown on drawings and as required including voltage and speed control, emergency stop, fault reset, lamp test, engine start, engine stop and indicating lights;
  13. engine alarm and shut down lamps with signals for conditions specified later in this Section and/or as shown on drawing and as required by local governing authorities having jurisdiction; provide engraved lamacoid identification nameplate for each lamp; provide panel with lamp test button;

14. required secondary and control wiring, type "TEW" 105°C rated, extra flexible wire with thermoplastic insulation and an overall flame retarding cotton braid, neatly harnessed, suitably secured and identified with slip on identification markers; Wiring to be colour coded to suit application and standards; Note that wiring for DC supply to control panel, wiring for cranking circuits and wiring for air box damper to be minimum number 10 AWG stranded; wiring within control panel to be number 16 AWG stranded; and wiring between control panel and engine generator set and transfer switch to be number 14 AWG stranded; provide separate junction boxes for AC and DC wiring;
15. ground fault relay to alarm on control panel in event of ground fault on windings of generator; current sensor mounted in generator connection box, and generator leads to pass through zero sequence circuit in connection box ; no internal ground connection in generator is permitted, and annunciator light provided on control panel face to indicate operation of this device; ground fault setting to be determined by genset manufacturer to suit specific application;
16. current transformers as required of appropriate size for local metering;
17. current transformers as required for electronic governor;
18. 24 volt DC control system with all fusing centrally located;
19. required potential transformers;
20. auxiliary contacts on devices to allow for functions required in controls system and interconnection to integrated systems such as fire alarm and building automation system;
4. Breakers mounted in control panel integral with genset include following features:
  1. moulded case type main breaker: fixed mounted moulded case circuit breaker as required, and where frame size exceeds 225 A, to be complete with solid state adjustable trip unit; in absence of direction, size and ampacity of breaker to be to suit application based on code requirements and genset manufacturer's recommendations; breaker setting to be such that generator short circuit output will trip breaker; trip unit to include adjustable long, short, instantaneous, time delay and ground fault alarming; exact settings to be determined by genset manufacturer to meet specific applications; exact breaker type to be as recommended by breaker and genset manufacturer to meet such applications and be reviewed with Consultant prior to ordering;
  2. auxiliary contacts on main breaker for monitoring and alarm indication in open position;
  3. moulded case load bank breaker: type and frame size as main breaker, to be provided interconnected to system to allow for connection of a load bank during regular testing of genset; provide shunt trip and relays as required to interconnect in manner such that if load bank breaker is closed and loss of normal power occurs, load bank breaker will open and main genset breaker will close; exact breaker type to be as recommended by breaker and genset manufacturer to meet such applications and be reviewed with Consultant prior to ordering;
  4. auxiliary automatic moulded case breaker (typically 30A-3P, but refer to drawings for exact requirements) to feed damper controls and fuel oil pumps; review exact requirements with Consultant prior to ordering;
  5. refer to drawings for additional requirements.
5. Electronic controls to monitor various engine performance characteristics including, but not limited to, following:
  1. oil and fuel temperature;
  2. timing of engine;
  3. coolant pressure and level;
  4. oil and fuel pressure;
  5. running hours;
  6. air temperature;
  7. battery voltage;
  8. engine overspeed.



6. Provide controls, contacts and annunciation of shut downs (red) and warnings (amber) alarms for following conditions, conditions as per applicable CSA Standards and conditions as detailed on drawings:
  1. high oil temperature – red;
  2. high oil temperature warning – amber;
  3. high coolant temperature – red;
  4. low oil pressure warning – amber;
  5. low oil pressure – red;
  6. overcrank – red;
  7. overspeed – red;
  8. over voltage – red;
  9. low DC voltage – amber (alarm lamp complete with DC voltage sensor);
  10. cool down period – white;
  11. reverse power – red;
  12. undervoltage – red;
  13. low frequency – red;
  14. high frequency – red;
  15. low coolant level – amber;
  16. low fuel level – amber;
  17. battery charger failure – amber;
  18. water in fuel – amber;
  19. emergency bus alive – blue;
  20. generator bus alive – amber;
  21. ECS not in auto – amber;
  22. low engine temperature – amber;
  23. alarm silence – amber;
  24. alternator winding and bearing high temperature – amber;
  25. fuel leakage – amber;
  26. ground fault – amber;
  27. genset main breaker open - amber;
  28. automatic transfer switch in non-auto or bypass mode – amber;
  29. combustion air intake damper does not open to 85% after 30 seconds - amber;
  30. air shutdown damper (if applicable) – amber;
  31. ventilation dampers not open – amber;
  32. remote emergency stop station (if provided) – amber;
  33. ancillary building alarms as required;
  34. two spares for future.
7. Utilize high brilliant cluster type LED's for indicating lights that are continuously illuminated "ON".
8. Provide required type of contacts, wiring and connections to auxiliary building systems for applications as noted in Part 3, and for connections to remote annunciators where required.
9. Provide engraved lamacoid nameplate of each control operator, device and indicating light. Review with Consultant exact nomenclature prior to ordering.
10. Designer/manufacture of entire control system is required to:
  1. supply complete design, erection and layout drawings for system, indicating all wiring requirements, interfacing or interconnection provisions required to completely integrate controls with all remote apparatus;
  2. assemble, wire and pre-test system components prior to shipment to site; such tests to be witnessed by Consultant at their discretion; all defects noted and corrected, and system retested prior to leaving plant;
  3. assist in installation and oversee work to ensure that it meets with requirements;

4. carry out a site test of system in conjunction with other components in standby power system and demonstrate its power operation to satisfaction of Owner and reviewed with Consultant.

## **2.10 ADDITIONAL ENGINE GENERATOR SET REQUIREMENTS**

1. Provide type of wiring conductors, terminations and ancillary devices, and other requirements necessary to fully install and connect integrated components and accessories. Applications include for power, control, signalling and integration. Confirm exact requirements with genset vendor. Provide fire rated conductors for specific applications of life safety and other similar applications. Products and work to be in accordance with genset vendor's instructions and requirements, requirements of local governing codes and local governing authorities, and CSA 282.
2. Nameplates/Labelling:
  1. Provide identification painting, engraved lamacoid nameplates, labelling, and warning signage to Owner's requirements and reviewed with Consultant. Identify each component on panels, piping, conduits, etc.
  2. Provide ULC listed labels clearly identified for components and in locations to approval of local governing authorities and TSSA.
3. Supply tools and spare parts required for normal maintenance and adjustment of genset, including:
  1. one complete set of fuel oil filter elements complete with gaskets;
  2. one complete set of lubricating oil filter elements complete with gaskets;
  3. one complete set of air filters;
  4. two complete sets of spare fuses;
  5. two complete sets of spare lamps for all indicating and warning lights;
  6. one complete set of spare belts;
4. Submit sound pressure levels for engine generator set to Consultant for review and Owner acceptance, prior to units being shipped to site.
5. After on-site successful testing, touch up paint gensets with manufacturers supplied paint. An additional one litre of touch up paint must be shipped loose with each unit and turned over to Owner. Paint control panel with corrosion resistant enamel paint to match genset finish. Exact finishes are to be approved by Owner and reviewed with Consultant prior to ordering of paint.
6. Genset manufacturer/supplier is responsible for factory testing and on-site testing of genset, as specified in Part 3 of this Section.
7. Include provisions to duct/drain/filter all waste emissions/leaks, to satisfaction of Owner and reviewed with Consultant. Under no circumstances are waste emissions or waste fluids to be released into room. Provide proper ducting/piping/filtering.
8. Components of genset control system and wiring between components functioning as part of this system, to comply with required CSA and local building code requirements with regards to minimum 2-hour fire resistance rating provisions.

## **2.11 EMERGENCY POWER OFF (EPO) PUSHBUTTONS**

1. Mushroom head, minimum 38 mm (1-1/2") diameter, exterior remote mounted emergency power off (EPO) station with hinged framed break glass cover with locking handle operator, mounted on exterior wall of enclosure; lock operator to be keyed to Owner's requirements.
2. Acceptable manufacturers are Rockwell Automation (Allen-Bradley), RCI, Schneider Electric and GE.

## **2.12 TESTING, START-UP, VERIFICATION AND TRAINING**

1. Refer to Part 3 for additional requirements.

2. Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with Contractor.
3. Be present to assist during third party testing and commissioning.
4. Perform testing at times approved by Owner and reviewed with Consultant.
5. Provide instructions on system operating and maintenance.

### **2.13 ACCEPTABLE MANUFACTURERS/SUPPLIERS**

1. Selected engine-generator sets to be provided from listed approved genset suppliers and be packaged sets that are factory assembled, factory type tested and warranted together.
2. Acceptable genset suppliers are:
  1. Cummins Eastern Canada LP;
  2. Toromont Cat. Ltd.;
  3. WAJAX Power.
  4. Generac Power Systems
3. Acceptable engine manufacturers are:
  1. Cummins;
  2. Caterpillar;
  3. MTU-DDC.
4. Acceptable alternator manufacturers are:
  1. Newage Stamford;
  2. Caterpillar;
  3. Marathon.
5. Acceptable instrument manufacturers are:
  1. Crompton Instruments;
  2. Basler;
  3. Yoko-gawa.
6. Products to be provided must be CSA approved and labelled, or inspected and approved by Electrical Safety Authority.

## **3 Execution**

### **3.1 INSTALLATION OF GENSETS AND ENCLOSURES**

1. Provide gensets and enclosures as specified and detailed. Refer to drawing details and notes for additional requirements. Refer to Section 26 32 05 for enclosure requirements and installation requirements. Perform required installation work and coordinate work between trades.

### **3.2 TESTING REQUIREMENTS FOR GENSETS**

1. Perform factory test of engine generator sets prior to delivery to job site. Include for and arrange for Owner and Consultant to witness factory tests and schedule tests at time acceptable to Owner and Consultant. Include "out of town" expenses such as transportation, lodging, meals, etc., for Owner and Consultant to witness factory testing.
2. Notify Owner and Consultant at least two weeks in advance of tests. Should additional tests be required due to failure to comply with conditions specified in this article, costs (all travel expenses, accommodation if required, plus seven hundred and fifty dollars \$750.00 per day) for Consultant to witness these additional tests are to be borne by genset manufacturer/supplier. Genset manufacturer/supplier to be responsible for full arrangements.

3. Tests to include period(s) of minimum 4 hours continuous operation under full load conditions as directed by Consultant. Number of periods of testing to be quantity as required until successful testing of specified requirements to satisfaction of Owner and Consultant.
4. Ensure that proper 100% capacity resistive type artificial load banks are available for tests. Factory testing to include use of strip chart recording instruments to confirm that engine generator set complies to all specified requirements in frequency, voltage and current regulation as specified herein this Section. Submit reports for Consultant's review and obtain Owner's approval prior to shipping gensets to site.
5. Notify Owner and Consultant minimum 2 weeks in advance of onsite testing. Under direction and in presence of Owner and Consultant, genset manufacturer's authorized technician to provide tests at site on genset and associated equipment when installation is complete, but before acceptance of same. Coordinate with independent distribution system testing company specified in article entitled, "Distribution System Testing and Coordination Study," in Section entitled Electrical Work Testing, to ensure that engine generator set and associated equipment performs with emergency power distribution system in accordance to requirements of all applicable CSA Standards. Refer to and provide additional applicable testing requirements of distribution system testing and coordination study article.
6. Coordinate and arrange for manufacturer's trained mechanic to conduct such tests and to make all required changes and adjustments found necessary by such tests. Repeat tests until all defects are corrected and equipment operates properly to Consultant's satisfaction. Perform general operational testing and other testing as per CSA Standards and requirements herein specified. Perform full load test, which is to include period(s) of minimum 4 hours continuous operation under full load conditions as reviewed with Consultant. Number of periods of testing to be as required to successfully demonstrate that genset and associated equipment complies with specified parameters to satisfaction of Owner and reviewed with Consultant. Perform initial testing with load banks. Perform testing with building loads when approved by Owner and reviewed with Consultant.
7. On site testing to be performed at times acceptable to Owner and reviewed with Consultant. Be responsible for costs of additional testing due to failure of genset to perform to specified standards, with additional expenses in effect as specified previously for factory testing. Supply variable load banks and connecting cables, sized for 100% capacity of plant, for testing procedure indicated herein.
8. Include for license electrician to be on site for testing, verification and commissioning Work, to make any required distribution system changes necessitated by Work. Arrange for genset supplier's controls contractor to be present for testing and commissioning.
9. Upon completion of installation of equipment, by Contractor, equipment manufacturers to inspect installation of each complete equipment assembly and certify in writing satisfactory installation and operations of same, to Owner. Submit detailed list of deficiencies to Consultant.
10. Equipment manufacturers to include for site visit to inspect, test, perform start-up, and verify installation to ensure that installation and Contractor is in compliance with Contract Documents.
11. Obtain approvals from local governing authorities including Technical Standards and Safety Authority (TSSA).
12. Upon acceptance of genset power plant, arrange for manufacturer's technician to instruct Owner's operating personnel in correct operation and maintenance of plant. Provide DVD recording of such instruction.
13. Perform test procedures in accordance with test sheets found at end of this Section. Submit reports signed and bound to Consultant using these typical sheets.

14. Coordinate responsibility for fuelling of main fuel tanks with General Contractor and Mechanical Contractor to ensure they are fully fuelled. For fuel oil used during onsite testing, upon acceptance of tests and prior to turn over to Owner, refill storage tank(s) with fuel oil. Submit copy of signed certificate declaring tanks have been re-filled and amount of fuel filled.
15. In addition to requirements specified in this Section, refer to requirements of Section entitled Electrical Work Analysis and Testing.
16. Following are general typical guidelines for testing of gensets and controls. Review exact requirements with Consultant and Commissioning Agent prior to start of Work. Additionally, contact genset manufacturer and obtain their recommended testing procedures for specific gensets of this Project. Coordinate with genset supplier.
17. Operational Tests:
  1. With engine in a "cold start" condition and emergency load at its normal operating level, simulate a power failure by means acceptable to Consultant. Do not interrupt existing services unless approved in writing by Owner and reviewed with Consultant. Test load to be load which is normally served by emergency power system. Unless instructed by or approved in writing by Owner and reviewed with Consultant, do not use building loads for testing. Provide variable load banks sized for loads as required.
  2. Continue operational test for 1 hour, after which time, restore normal power and demonstrate satisfactory transfer of load and shutdown of emergency generating sets.
  3. Observe and record following:
    1. time delay on start;
    2. cranking time until engine starts and runs;
    3. time required to come up to operating speed;
    4. time required to achieve a steady-state condition with all transfer switches transferred to emergency position;
    5. voltage, frequency, and amperes at start-up and at any observed change in load;
    6. engine oil pressure, water temperature where applicable, and battery charge rate at 5 min intervals for first 15 minutes and at 15 minute intervals thereafter;
    7. time delay on retransfer for each transfer switch;
    8. time delay on engine cool down and shutdown;
    9. check and test operation of engine starting system, and jacket coolant heaters.
  4. Full Load Test
    1. Following operational test, subject genset to a 4 hour 100% load test.
    2. Provide variable load bank for testing, unless use of building load is permitted in writing by Owner and reviewed with Consultant.
    3. Full load test may be initiated by any method that will start engine and, immediately upon reaching its rated speed, pick up full load in one step.
    4. Record data for items listed above, at first load acceptance and every 15 minutes thereafter until completion of test period.
  5. Cycle Crank Test:
    1. Prevent engine from running by utilizing any method recommended by manufacturer. Place control switch in "run" position to cause engine to crank.
    2. Engage engine starting system to provide a cranking cycle consisting of:
      1. 30 seconds of continuous cranking; or
      2. three (3) 10 seconds crank attempts separated by 10 seconds rest periods;
      3. repeat crank cycle a second time to demonstrate that batteries have sufficient capacity for a total cranking time of 60 seconds;
      4. demonstrate time required to recharge batteries to meet requirements.

6. Safety Shutdown and Alarms:
  1. Test gensets as recommended by manufacturer and as described herein this Section to ensure that safety shutdowns and alarms are fully functional.
7. Ventilation:
  1. During testing of gensets, demonstrate that sufficient ventilation is provided for room/enclosure housing gensets, in accordance with requirements of CAN/CSA-C282.
8. Voltage and Frequency:
  1. Perform this test in accordance to CAN/CSA-C282.
9. Oil Analysis:
  1. Perform this test in accordance to CAN/CSA-C282.
10. Exhaust System:
  1. Coordinate with Mechanical Division as applicable, to perform required testing to show that performance of integrated engine with exhaust system and stack complies with Specification.

### **3.3 EMISSIONS TESTING**

1. Include for Owner approved specialist noise and air emission's company to provide testing and required equipment and personnel to verify that complete genset assembly complies with air and noise emissions requirements of issued documents and of MOE. Include acoustical testing to verify sound levels during operation at full load. Perform required operating and maintenance of gensets during testing.

### **APPEDIX: ENGINE-GENERATOR TEST REPORT FOLLOWS**

#### **END OF SECTION**

**APPENDIX: ENGINE-GENERATOR TEST REPORT**

PROJECT:	_____	Project No:	_____
	_____	Date:	_____
	_____		
OWNER:	_____		
ARCHITECT:	_____		
CONSULTING ENGINEERS: <u>AECOM Canada</u>			
LOCATION:	_____		
	_____		
PRESENT:	_____		
	_____		
	_____		
ENGINE DATA:	_____	SERIAL NUMBER:	_____
	_____		
	_____		
UNIT – GENERAL			
CONTROL PANEL – GENERAL			
VIBRATION CONTROL			
START-UP TIME			
COLD UNIT:	_____		
HOT UNIT:	_____		





METHOD OF LOADING (SPECIFY):

TIME IN MINUTES:

LOADING

AMPS – PHASE 1

AMPS – PHASE 2

AMPS – PHASE 3

VOLTS – PHASE 1

VOLTS – PHASE 2

VOLTS – PHASE 3

FREQUENCY (HZ)

OIL PRESS. (PSI)

OIL TEMP. (°C)

WATER IN TEMP. (°C)

WATER OUT TEMP. (°C)

JACKET TEMP. (°C)

EXHAUST. TEMP. (°C)

ENGINE SPEED (RPM.)

CHARGER

POWER FACTOR

GENERATOR TEMP. (°C)

ROOM TEMP. (°C)

EXHAUST SMOKE

KW. RATING

VACUUM (GAS UNITS ONLY)

AECOM Canada Ltd.

Date: \_\_\_\_\_

Per: \_\_\_\_\_

END OF APPENDIX

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section, including but not limited to following:
  1. genset enclosure;
  2. enclosure accessories and components;
  3. fuel tanks.
2. Shop drawings to include following:
  1. full design detail drawings;
  2. layouts and dimensions;
  3. equipment capacities;
  4. wiring schematics;
  5. integrated systems.

### 1.2 TYPICAL DETAILS

1. Refer to typical details found on drawings for references to products and/or execution required in this Section.

### 1.3 WARRANTY

1. Warrant (full parts and labour) entire genset enclosure and accessories, in writing, to be in strict accordance with Specification and free from defects for minimum one (1) year from date of site performance and acceptance test and subsequent written acceptance by Consultant.
2. Above warranty requirements and issues to be provided by genset manufacturer or manufacturer's authorized genset supplier.

## 2 Products

### 2.1 GENSET ENCLOSURE (SKIN-TIGHT)

1. "Skin-tight" type genset enclosure to be provided to house genset complete with silencers, control panel, batteries and accessories. General features include but are not limited to following:
  1. outdoor, weatherproof, corrosion resistant;
  2. sound attenuated;
  3. non-combustible fire-rated construction designed to required local governing authority and code requirements;
  4. heavy duty aluminium or steel outer skin over heavy-duty steel framework construction and primed and finished with corrosion resistant paint finish;
  5. sound insulated panels;
  6. exhaust silencer;
  7. dry type distribution transformer and breaker panelboard, sized to accommodate loads of enclosure components requiring power feeds; factory prewired breaker panelboard to be 120/208 VAC with main breaker and branch breakers for feeding genset and enclosure components and accessories; include three (3) additional spare 15A-1P breakers installed in panel;
  8. locking access panels;
  9. flexible coolant and lubricating oil drain lines, that extend to exterior of enclosure, with internal drain valves;
  10. external radiator fill provision;
  11. radiator guard;
  12. heavy duty steel beam mounting base;
  13. insulated ventilation louvers and dampers;

14. insulated enclosure with non-hydroscopic materials;
  15. pitched roof, such that precipitation falling on roof does not drain over access doors;
  16. corrosion resistant stainless-steel door hardware, hinges and locks;
  17. locking compartments for storage of manuals, spare parts and tools;
  18. warning signs;
  19. vandal proof construction;
  20. finish painted in colour as approved by Owner and reviewed with Consultant;
  21. minimum one GFI duplex receptacle located inside enclosure on each side, and weatherproof GFI receptacle on outside of enclosure;
  22. switches controlling AC powered LED lamps mounted in vapour tight and gasketed internal fixtures; also controlled with 60 minutes adjustable timer;
  23. switched controlled vapour tight, gasketed DC light connected to main batteries; also controlled with 60 minutes adjustable timer;
  24. external AC weatherproof and vandal proof LED type fixture with photocell control over panel access door;
  25. thermostatically controlled forced air internal heater to keep interior temperature at minimum temperature as per CSA C282;
  26. exhaust fan for internal high temperature heat removal from enclosure and include modulating thermostat control;
  27. emergency power off (EPO) station consisting of minimum 38 mm (1-1/2") diameter mushroom head, mounted in weatherproof enclosure with break glass cover for emergency access and locking operator for authorized access; typically mount recessed or semi-recessed in exterior wall of enclosure at each walk-in door; lock operator to be keyed to Owner's requirements; provide "EMERGENCY POWER OFF" identification lettering; review exact nomenclature with Consultant prior to ordering;
  28. fuel tank;
  29. storage cabinet for operating and maintenance manuals and spare parts;
  30. seismic restraints as required by local governing building code;
  31. in applications of use of dissimilar materials, include provisions to prevent corrosion.
2. Enclosure to meet applicable codes and standards enforced by local governing authorities, including but not limited to:
    1. CSA C282;
    2. ULC Standards;
    3. National Fire Protection Association (NFPA);
    4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
    5. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE);
    6. local applicable building codes;
    7. local applicable electrical codes;
    8. Ontario installation code for oil-burning equipment (Based on CSA B139, with Ontario amendments);
    9. Technical Standards and Safety Authority (TSSA).
  3. Overall exterior enclosure construction to be of galvanized steel or aluminum. Slope roof or provide means to direct precipitation landing on roof in direction reviewed with Consultant, such that precipitation drains in direction acceptable to Owner.
  4. Enclosure assembly to be designed such that genset components needing routine maintenance and servicing or replacement are easily accessible from access doors. Access doors to be locking, hinged type with retainers to hold doors open during service. Rooftop enclosures with fuel tanks to include access doors/panels sized to accommodate passage of fuel tanks.
  5. Intake and exhaust louvers to be located at height to minimize effects from flood waters and accumulated snow levels. No roof penetrations except for exhaust stack.

6. Provide motorized intake louvers to minimize air flow through enclosure when generator set is not operating. Louvers to include provisions to prevent accumulation of ice or snow that might prevent operation. Louvers to be spring open, power close operation, as per governing local authority and code requirements.
7. Enclosures to include weatherproof cable stub and openings for connection cabling through underside of base. Provide load bank cabling entry and temporary genset connections via openings with flexible boots behind a gasketed locking hinged door. Boots to prevent egress of any precipitation into enclosure when cables are run into enclosure. Exterior components and parts to be corrosion resistant and weatherproof. Coordinate location of cable access openings to suit structural base. Provide cable connection box with copper bussing.
8. Sound-attenuated housing rated to allow generator set to operate at full rated load in an ambient temperature of up to 40°C (104°F).
9. Acoustics:
  1. Maximum permissible sound emissions criteria for enclosure at engine full load rating to be net 72 dBA at 7m (23') including provisions for reverberations from neighbouring walls.
  2. Selection of silencer (muffler) to be coordinated with design of enclosure to meet sound level requirements.
  3. Submit with shop drawings, certification letter from a recognized acoustical authority certifying factory testing acoustical performance of enclosure housed genset, with genset operating at full load rating in accordance with specification requirements.
  4. Include for a qualified acoustical engineer to perform an acoustical field test during onsite genset testing, to certify performance and provide documented test report. Measure noise levels at 10 different locations as reviewed with Consultant.
  5. Obtain and submit required approvals from local governing authorities having jurisdiction.
  6. Materials of construction to be to general accepted trade standards unless more stringent requirements are required by any recent codes or regulations by local governing authorities. Ensure that most recent applicable standards are met.
10. Provide complete grounding and bonding conductor system in compliance with code requirements, complete with conductors from equipment and exterior ground rods or for connection to main building grounding system. Refer to Section entitled Grounding and Bonding for additional grounding and bonding requirements.
11. Fuel System:
  1. Provide required fuel oil system meeting CAN/CSA B139 and TSSA requirements.
  2. Provide ULC S601 listed and labelled sub-base fuel tank. Installation to be in compliance with local governing authority regulations. Fuel tank to be double-walled, steel construction and include following features:
    1. enough fuel capacity to operate genset for a minimum 24 hours under full load nameplate rating;
    2. emergency tank and basin vents; vents to include vertical extension pipe to exterior of enclosure to meet local governing technical standards and safety authority standards;
    3. mechanical fuel level gauge;
    4. fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by engine manufacturer and in compliance with CSA, ULC and other applicable codes;
    5. shut-off valves certified to CSA and either cUL or ULC listed to ULC 842, Class 600;
    6. provide local filling capability with required ULC labelled fittings;
    7. leak detection provisions, wired to generator set control for local and remote alarm indication; provide fuel level leak detector inside void space of double wall tank and provide wiring and tie-in of fuel leak signal to genset control panel provide required relays for interconnection to leak detection system; system to include contacts as required for connection to main building automation system (BAS);

8. high and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level;
  9. basin drain;
  10. integral lifting provisions;
  11. access to/in tank as per governing authority requirements.
12. Engine exhaust system features are as follows:
  1. Custom manufacturer heavy duty steel exhaust flange to extend from silencer to roof thimble. Exhaust system exhausts out of enclosure roof through an insulated roof thimble designed for application and with weatherproof sealed pre-fabricated flashed roof curb. Thimble to be of heavy duty galvanized steel corrosion resistant construction.
  2. Terminate exhaust pipe flange minimum 450 mm (18") above roof line and top with required temporary weatherproof cap. Exhaust stack stub assembly to be capable of supporting an on-site installation of a vertical exhaust stack up to 10' (3m) high. Provide guy wires as required for proper support. Interior exhaust piping to be insulated with minimum 50 mm (2") thick Rockwool type insulation suitable for application. Exact height of exhaust stack to suit MOE Certificate of Air and Noise Approval criteria coordinated with noise and emissions consultant and drawing requirements.
  3. Exhaust stack and piping to meet requirements of local governing technical standards and safety authority standards and other required governing authorities. Exterior vertical exhaust stack to be constructed of minimum schedule 40 rigid black steel, or double wall construction stainless steel chimneys as manufactured by Selkirk or Van-Packer. Diameter to suit genset sizing as noted and confirmed with genset manufacturer. Exhaust stack to extend to height reviewed with Consultant. Stack design and layout to prevent ingress of water/snow back into silencer and means reviewed with Consultant to drain any accumulation in exhaust piping away from enclosure. Stack in position to be designed to withstand anticipated wind forces and other forces of nature. Provide required supports and/or guy wiring as per stack manufacturers recommendations as coordinated with genset vendor.
  4. Coordinate routing, dimensions, and configuration of exhaust system with enclosure dimension restrictions and equipment layout as detailed and as noted.
  5. Ensure that exhaust stack is positioned in location such that emissions do not become drawn into enclosure during operation. Weatherproof and seal openings in roof due to exhaust stack work.
  6. Where required to suit exhaust configuration of respective gensets, provide properly sized black steel pipe welded "Y" connector.
13. Fire Alarm System Provisions:
  1. Enclosure to include provisions of empty conduits with fish cord and boxes for installation of future detectors and associated fire alarm devices provided by main building fire alarm vendor. Coordinate work with fire alarm vendor. Fire alarm device conduit runs to allow for Class A looped running of system wiring, extending from device boxes to termination box near enclosure wall easily accessible by Contractor for extension to main building. Provide separate conduit loop runs for each of initiating devices and for indicating devices. Coordinate work with respective vendors.
  2. Provide fire extinguishers of CO2 type, minimum 10 pounds (4.5 kg), and mounted within enclosure. Exact type of fire extinguisher to be as recommended by genset vendor to suit application. Provide mounting bracket and install on interior wall adjacent door. Include identification label on outside of door identifying location of extinguisher.
14. Access and Security Signs, and Nameplates/Labeling:
  1. Provide identification painting, engraved lamaroid nameplates, labelling, warning signage and access and security signage to Owner's requirements. Identify each component on panels, piping, conduits, etc.

2. Provide ULC listed labels clearly identified for components and in locations to approval of local governing authorities and TSSA.
3. Provide signage as follows:
  1. corrosion resistant, weatherproof and resistant to fading from sunshine;
  2. red lettering on white background;
  3. be permanently affixed;
  4. nomenclature to be reviewed with Consultant prior to manufacturer, but generally to read as follows:
    1. exterior: "AUTHORIZED PERSONNEL ONLY";
    2. above genset: "WARNING – KEEP OFF – GENSET MAY START AUTOMATICALLY AT ANY MOMENT".
15. Testing, Start-up, Verification and Training:
  1. Perform standard factory testing as integrated with factory witness testing of gensets specified in respective genset Sections. Test equipment and systems and verify proper operation. Document testing and results in reports signed by genset enclosure manufacturer's authorized technician. Submit copies of report to Consultant.
  2. Onsite after installation inspection, testing, start-up, and verification to be integrated with genset testing, start-up, and verification work as specified in respective genset Sections. Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with Contractor. Document testing and results in reports signed by genset enclosure manufacturer's authorized technician. Submit copies of report to Consultant.
  3. Be present to assist during onsite third-party testing and commissioning.
  4. Perform testing on dates and at times reviewed with Consultant.
  5. Provide instructions on system operating and maintenance.
16. Acceptable enclosure manufacturers are as recommended by genset vendors/suppliers.

### **3 Execution**

#### **3.1 INSTALLATION OF GENSET AND ENCLOSURES**

1. Provide genset and enclosure as specified and detailed. Refer to respective genset section for genset requirements.
2. Prepare and submit with shop drawings, necessary design, erection and layout drawings, wiring, piping and control diagrams as required for proper execution and completion of Work.
3. Coordinate controls work both at factory and on site and include for required interface work to equipment on site.
4. Prior to start of Work, prepare schedule of Work and submit to Consultant for review. Manufacturer/supplier to upon successful factory witness testing of unit, arrange and coordinate delivery and transporting of unit to site.
5. Perform testing, start-up and verification work as specified herein and in respective genset section.
6. Provide transporting and hoisting of gensets and enclosures as required to locate into position. Coordinate responsibility and requirements with General Trades Contractor.
7. Perform and coordinate installation requirements with requirements of respective genset specification Section. Provide components and installation in factory as required.

8. For on grade installations: Coordinate structural base requirements for mounting of containerized genset with Structural Consultant and General Trades Contractor. Provide concrete pad as detailed on drawings. Unless otherwise detailed or noted on drawings, concrete pad to be typically of dimensions covering size of genset enclosure and extending 600 mm (2') beyond each side, and of depth to accommodate weight of entire unit with full loaded fuel. Include for seismic restraints as required.
9. Provide required vibration isolation and seismic restraints in accordance with Specification, Structural documents and as per local governing building code requirements. Secure genset on vibration isolation springs to its base by means of 13 mm (1/2") diameter "Rawstud" high tensile strength steel anchor bolts. Ensure that set is plumb and level. Check engine generator alignment when mounting is complete. If necessary, realign in accordance with manufacturer's recommendations.
10. Provide shore power feeders in conduit from dedicated breakers in panelboards in main building, serving container genset, and connect to integral power panel and devices as required. Connect feeders to panel and ensure that components and accessories that require external power are fed from panel breakers, as required. Identify breakers in panel. Make required connections to genset with suitable cabling and lugs. Refer to notes on drawings. Applicable distribution equipment to be provided to general standards of electrical products specified in other Sections.
11. Connect power wiring to building distribution system as reviewed with Consultant.
12. Exterior feeders in conduit to be RWU90 or TWU in rigid galvanized steel conduit, or in rigid PVC underground, unless otherwise noted. Coordinate conductor and conduit runs with genset vendor to suit enclosure requirements.
13. For initiating start-up upon loss of normal power of electrical distribution system, provide fire rated MI wiring from genset control panel to appropriate transfer switch contacts or to other designated loss of normal power signal as reviewed with Consultant, to initialize engine start-up upon loss of normal power.
14. Fill radiator with a solution of 50% clean water and 50% permanent type ethylene glycol (exact ratio to be confirmed with genset manufacturer). Check specific gravity of engine coolant. Add glycol and/or water if required.
15. Check level of engine lubricating oil and add if required. Check and test operation of engine starting system, and jacket coolant heaters. Include acoustical testing to verify sound levels during operation at full load.
16. Make conduit connections to generator set with liquid tight flexible conduits.
17. Provide exhaust stack extension and mount to enclosure as per genset supplier's instructions. Secure as required.
18. Connect and ground unit with proper copper ground conductors. Ground and bond equipment as per local electrical code requirements. Refer also to requirements of grounding and bonding article. Interconnect grounding to main building grounding system as may be required by local codes and electrical authority.
19. Refer to and provide additional applicable testing requirements of distribution system testing and coordination study article.
20. Provide and connect control panel wiring to fire alarm system, and if necessary, provide required low voltage relays, wiring and contactors from generator control panel to fire alarm system control panel for supervision and annunciation of "Main Breaker Open", "Generator Running", "Generator Failure to Start", "Low Voltage Generator Battery" and "Low Fuel Level/Pressure".

21. Include additional points as required by local governing authorities and codes. Extend and connect these points to BAS and fire alarm system. Extend control/communications wiring in conduit to respective main building systems, as required. Engage respective system vendors to provide required connections to and software programming to interconnect systems.
22. Coordinate fire alarm device installation work with main building fire alarm vendor. Extend fire alarm circuits from enclosure to main building and connect to local transponder/control panel designated by fire alarm vendor. Provide required low voltage relays, wiring in conduit and contactors from generator control panel to fire alarm system control panel for common supervision and annunciation of genset alarms. Coordinate with Mechanical Division BAS vendor to ensure that genset alarm points are connected to BAS as a common alarm. Extend control wiring of type suitable for specific applications and as recommended by vendor of system being connected to and terminate at panel designated by system vendor. Include for additional spare 3m (10') coiled length at end. Include for system vendor to make required connections to panel and required programming.
23. Coordinate and arrange for main building fire alarm system vendor and security system vendor to provide respective system devices, wiring and connections. Extend circuits from common junction box in genset enclosure to main building and connect to respective main building systems to annunciate specified separate zones/points. Provide wiring and conduit of type to suit application in accordance with local governing codes and as recommended by system manufacturer.
24. Coordinate required fuel oil connections (supply piping and control/monitoring wiring) with Mechanical Division Contractor to ensure proper fuel feed to genset and monitoring of fuel level.
25. Seal enclosure openings for cables, piping, conduits and other penetrations after installation, with water tight fire stopping and smoke seal materials.
26. Provide concrete bollards as required. Coordinate concrete work, excavation and backfilling work with respective general trades. Refer to Section 26 05 00 for additional related requirements.
27. Test and verify functions of enclosure with genset testing.
28. Obtain local governing technical standards and safety authority and other required local governing authority approvals and certifications.
29. Additionally, refer to testing, coordination and verification requirements in respective genset section and Section entitled Electrical Work Analysis and Testing and include applicable requirements.

**END OF SECTION**



## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section, including but not be limited to following:
  1. load banks with accessories;
  2. genset connection boxes and controls;
  3. load bank connection boxes and controls.
2. Include following with shop drawings:
  1. full design detail drawings and layouts;
  2. wiring schematics;
  3. dimensions and weight of equipment and associated major components;
  4. electrical characteristics;
  5. power and performance data;
  6. point by point description of control system software sequence of operation;
  7. nameplate data identifying electrical characteristics;
  8. warning signs and proposed nomenclature.

### 1.2 TYPICAL DETAILS

1. Refer to typical details found on drawings for references to products and/or execution required in this Section.

## 2 Products

### 2.1 TEMPORARY GENSET CONNECTION BOX

1. Temporary genset connection box to be common box provided to accommodate easy exterior connections to emergency power distribution system and to be as detailed on drawings and as follows:
  1. CSA approved and/or ULC listed enclosure and components;
  2. minimum NEMA 3R weatherproof steel, galvanized steel construction with corrosion resistant finish of colour approved by Owner and reviewed with Consultant;
  3. unless otherwise indicated on drawings, sized as per CSA and ESA requirements;
  4. with hinged gasketed door with 3-point latch and key lock with provisions for safety padlocks; key can only be removed when door is closed and locked;
  5. conduit entries with proper bushings and sealed to prevent egress of precipitation;
  6. entries for temporary cable to be typically from below through gasketed sliding access panel opening or equivalent means;
  7. tin plated copper bussing for cable tap off provisions with holes in each bus to accommodate feeders from distribution system; each lug on feeders to be dual annular crimped, long barrel and two hole type, bolted to bussing with 13 mm (1/2") bolts with lock washers, nuts and flat washers; bus to be angled to properly facilitate connection of cabling; bus to be suitably secured to handle weight of connection cables;
  8. copper ground bus and ground lugs;
  9. suitable termination box for control wiring interconnections from temporary genset to emergency power distribution equipment and control system; include required connector, terminal strips, hinged steel cover, conduit entries, engraved lamaroid nameplate identifying purpose, connecting conduit extending out through main connection box side and weatherproof cap with chain for sealing end of exterior conduit opening; refer to drawings for additional wiring requirements;
  10. control wiring extending from connector and other terminations to control system;

11. for temporary power cable connections, Cam Lok type or approved equal, CSA approved, quick connector receptacles of voltage and ampere rating to accommodate maximum rating of box; receptacles to be clearly labelled; submit proposed connector type and details with shop drawing submission for approval from Owner and review with Consultant;
  12. control signal wiring connections as required to connect temporary connections to building control systems and equipment;
  13. entries for temporary cables to be such that design to be weather-tight to prevent any ingress of water or precipitation into connection box;
  14. Kirk key type mechanical interlocks on main door and interlocked with connected breaker such that main door cannot be opened unless breaker is in open position; coordinate requirement for mechanical interlock on breaker with equipment vendor supplying equipment with interconnected breaker;
  15. conduit entries and mounting provisions completely sealed weather-tight to prevent any ingress of water or precipitation into connection box;
  16. stainless steel and welding cleaning paste/solution to rid complete stainless steel surfaces of any material that may promote corrosion or discolouration; supply and turn over sufficient quantity;
  17. engraved lamacoid nameplates and signage on enclosure with appropriate component identification and box instructions regarding use; submit proposed scheme, colours and nomenclature with shop drawings.
2. Review mounting requirements with Consultant. Locate and install boxes to be self-standing and secured to concrete bases with conduit/duct entries from below. Include required Unistrut type corrosion resistant stainless steel C-channels for support of boxes. C-channels to raise boxes above bases. Refer to drawings.
  3. Provide required distribution conductors and control wiring, to suit applications to local code requirements, from connection box to respective system components as shown and as required.
  4. Complete assembly to be approved by local governing electrical authorities and inspection authorities, and be suitable for intended application.
  5. Acceptable manufacturers include:
    1. Phoenix Controls (Chris Wight, 289-291-0161 ext 26);
    2. Commercial Switchgear.
    3. Or Approved Equivalent.

## 2.2 LOAD BANKS

1. ASCO-Avtron, Series 4800, CSA approved, ULC listed and labelled, high capacity permanent mounted, multi-bay, outdoor weatherproof, resistive load bank as follows:
  1. 500 Kw total load, with 50 Kw load steps;
  2. 600 VAC, 3 phase, 60 Hz; (confirm on drawings and coordinate);
  3. designed for continuous duty cycle operation with no limitations;
  4. operate in an ambient temperature of -28°C to 49°C (-20°F to 120°F);
  5. corrosion resistant chromium alloy wire resistive elements;
  6. standard unit mounted controls consisting of operator control panel with power on/off switch, power on lights, blower fan on/off buttons, fan failure light, over temperature light, master load on/off switch, phase rotation switch and individual load step switches;
  7. controller to include components that monitor status of normal power during genset testing and when loss of normal power, controller to disconnect load banks from system and allow gensets to reconnect to system to feed required essential loads;
  8. digital metering and monitoring system with display of volts, amps, frequency and Kw;
  9. data logging software and infrared / USB interface cable to interconnect to PC to allow for real time data acquisition and trending of meter parameters from PC;
  10. branch circuit fusing on each load step, motor overload protection, over temperature protection and cooling air loss protection;

11. self-contained air cooling fans with integral TEFC or TEAO motors which are direct coupled to cooling fan blade; fan blade is airfoil design constructed from aluminum or non-corroding material; fan motor electrically protected against overload using a motor overload device, motor starting contactor and short circuit protected using current limiting fuses;
  12. control section control devices protected from effects of moisture and condensation;
  13. heavy duty welded steel base with forklift channels;
  14. transformers as required to provide control voltage;
  15. heavy gauge aluminized steel sound attenuated enclosure finished in baked polyester powder coated paint with corrosion and weather resistant finish; vertical exhaust hatches; bolt-on removable access panels; enclosure to minimum NEMA 3R rated for outdoor weatherproof applications; exposed parts to be corrosion resistant; exterior fasteners to be stainless steel;
  16. exhaust hoods angled and include interior baffle plates to direct falling rain from interior of load bank and be constructed of non-corrosive aluminized steel or aluminium;
  17. warning signage;
  18. dimensions of unit not to exceed as indicated on drawings.
2. Connecting cables: interconnecting cables terminated and extending from load bank breaker to load bank, sized to suit full load capacity of unit; cables to be flexible, weatherproof suitable for outdoor wet locations, UV resistant and complete with suitable terminations.
  3. Warranty: 24 month parts and labour warranty.
  4. Testing, Start-up, Verification and Training:
    1. Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with Contractor.
    2. Be present to assist during third party testing and commissioning.
    3. Perform testing at times coordinated with Owner and reviewed with Consultant.
    4. Provide instructions on system operating and maintenance.
  5. Acceptable manufacturer is
    1. ASCO Avtron.
    2. Or Approved Equivalent.

### 3 Execution

#### 3.1 INSTALLATION OF TEMPORARY GENSET CONNECTION BOX

1. Install connection boxes as required. Review final location with Consultant prior to roughing-in.
2. Review type of temporary cable connectors with Consultant prior to ordering.
3. Secure boxes raised up with Unistrut C-channels, onto concrete pads. Review mounting requirements with Consultant to suit pad where box is to be installed. Coordinate pouring of base to ensure base is sized to suit equipment enclosure and associated additional equipment dimensions.
4. Provide required feeders in conduit sleeve through wall. Provide proper sleeving and weatherproof firestopping materials to maintain fire rating of building wall surfaces and caulking to seal openings. Coordinate work with General Trades Contractor.
5. Extend various power, control, monitoring and alarm connection cabling in conduit from box to designated electrical distribution system equipment and control/monitoring connection points. Include start-up connections as required. Connect complete.
6. Install load bank connection box and connecting cabling to be parallel to building loads and to be used during building load transfer test.

7. Install mechanical interlock interconnections between lock of connection box door and respective locks and connect to respective breaker locks. Coordinate required shunt-trip requirements with respective equipment manufacturers. Review sequence of operation with Consultant prior to ordering.
8. Review enclosure finishes, and instruction labelling and warning signage nomenclature with Consultant prior to manufacturer.
9. Test installed assembly to satisfaction of Owner and Consultant. Include for full integrated testing of genset with testing of connection boxes. Obtain required certificates of approvals and submit copy to Consultant.

### **3.2 INSTALLATION OF LOAD BANKS**

1. Review installation location with Consultant prior to start of work.
2. Install load bank in accordance with manufacturer's instructions. Provide required load and control conductors in conduit and extend to load bank. Interconnect to electrical distribution equipment and connect complete.
3. Interconnect load bank to genset control system or transfer switch as required for load bank controller to obtain loss of normal power signal when connected during genset testing. Load bank to be automatically disconnected to allow genset to pick-up essential loads in event of loss of normal power to building, as required. Review exact requirements with Consultant prior to start off work.
4. After installation is complete, test load bank separately and as part of integrated genset control system, adjust as required and certify operation. Site test unit in accordance with manufacturer's instructions and recommendations. Tests which may be factory or onsite, to include electrical functional testing, verifying conformance to assembly drawings and specifications. Each load step to be cold resistance checked to verify proper calibration of resistive load steps and proper ohmic value. Perform tests using high potential equipment to ensure isolation of load circuits from control circuits and to determine isolation of load circuits from load bank frame. Perform tests of safety circuits to verify conformance to specification. Perform high potential insulation resistance test on electrical circuits, at twice rated voltage plus 1000 VAC to assure insulation integrity.
5. Review instruction labelling and warning signage nomenclature with Consultant prior to manufacturer.
6. Demonstrate and instruct operation and maintenance to Owner's personnel.
7. Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

### **END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.

## 2 Products

### 2.1 UNINTERRUPTIBLE POWER SUPPLY (UPS) UNITS

1. Eaton, CSA approved and ULC listed, 93PM series continuous duty, on line uninterruptible power supplies, as specified in following paragraphs and as noted on drawings.
2. General Features:
  1. Modular construction, with draw-out assemblies that can be quickly serviced or replaced as necessary.
  2. Double conversion topology.
  3. Scalable configurations on larger capacity units, of up to 4 identical modules paralleled allowing additional capacity to total rated kVA of unit or for redundancy, as noted.
  4. Each paralleled unit operates with its own battery string.
  5. Monitoring and control components provides self-diagnosis and self-correction where upon sensing a problem, automatically transfers unit to bypass and when alarm condition clears, automatically reverts back to normal power.
  6. Microprocessor controlled logic.
  7. EMI suppression; surge, spike and continuous brownout protection.
  8. Internal maintenance bypass.
  9. External maintenance bypass with matching cabinet.
  10. Internal battery pack to provide specified battery time at full capacity load.
  11. Battery monitoring of lifetime conditions, runtime remaining and battery temperature.
  12. Battery circuit testing.
  13. Communication interfaces.
  14. Cabinet enclosures.
  15. 100% front accessible.
  16. Required ancillary devices.
3. Applicable Standards:
  1. UPS unit to meet requirements of latest editions of applicable Standards including:
    1. CSA C22.2 107.1;
    2. ULC listings;
    3. IEEE 587/ANSI C62.41 Standards;
    4. FCC Rules and Regulations.
4. Performance Ratings:
  1. Output Power Capacity: Exact capacity as noted on drawings.
  2. Input and Output Voltage Ratings: As noted on drawings.
  3. Minimum 97% efficiency full load at unity power factor.
  4. Input and output voltages as noted on drawings.
  5. Input Power Factor: 0.99 min.
  6. Input Voltage Range: +10% to -10%.
  7. Input FREQUENCY RANGE: 40 to 72 Hz.
  8. Input Current Distortion: Less than 3% without input filter.
  9. Output Voltage Regulation: +/-1% from nominal output voltage for any steady state operating condition.
  10. Output voltage THD: Less than 1.5% maximum typical non-linear load.
  11. Overload current capability (with nominal line and fully charged battery, non-paralleled systems):

1. Double Conversion Mode: maintains voltage regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and 126% to 150% for 10 seconds, >151% for 300 ms.
2. Stored Energy Mode (typically on battery): maintains voltage regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and >126% for 300 ms.
3. On Bypass (single UPS systems): Continuous = 125%; Transient = 1000% peak current for 10 ms.
12. Common mode noise attenuation:
  1. -65 dB up to 20 kHz, -40 dB up to 100 kHz.
  2. > 100 dB with isolation transformer.
13. EMI Suppression: meets FCC rules and regulation 47, part 15, for Class A devices, CISPR22, and IEC62040-2 C2 and C3.
14. Electrostatic Discharge: meets IEC61000-4-2 level 3; 4 kV contact/8 kV air discharge.
15. Operating Temperature: 5°C to +40°C (+41°F to +104°F) without derating.
16. Storage Temperature: -25°C to 55°C (-13°F to 131°F).
17. Relative Humidity: 5 to 95%.
18. Altitude: 1000 m (3,300') without derating.
19. Audible noise: Less than 65 dBA (at 1 m 3') from any operator surface.
5. UPS Module Modes of Operation: UPS Modules operate as on-line, fully automatic system in following modes:
  1. Normal: Utilizing commercial AC power, critical load continuously supplied by inverter which powers load while regulating both voltage and frequency. Rectifier derives power from commercial AC source and supplies DC power to inverter. Simultaneously, battery charger charges battery.
  2. Battery: Upon failure of commercial AC power, critical load continues to be supplied by inverter, which obtains power from batteries without any operator intervention. There is no interruption to critical load upon failure or restoration of commercial AC source.
  3. Recharge: Upon restoration of AC source, charger recharges batteries and simultaneously, rectifier provides power to inverter. This is automatic function and causes no interruption to critical load.
  4. Bypass: If UPS module is taken out of Normal mode for overload, load fault, or internal failures, static bypass switch automatically transfers critical load to commercial AC power. Return from Bypass mode to Normal mode of operation is automatic. No-break transfer to and from Bypass mode is capable of being initiated manually from front panel.
  5. Energy Saver (or equivalent): UPS continuously monitor voltage and frequency of bypass source. When source parameters are within acceptable limits, UPS utilizes minimal/optimal combination of its internal subsystems to ensure acceptable power is always delivered to critical load, at a system efficiency of up to 99%. Energy Saver System is enabled and adjustable by user. System also provides maximum power conditioning any time bypass source variation levels exceed preset, adjustable limits. System is able to distinguish between upstream (utility) faults and downstream (load) faults, and react appropriately to protect and support critical load, without interruption.
6. Universal Power Modules: Each module contains:
  1. Rectifier/Charger:
    1. Converts incoming AC power to regulated DC output for supplying inverter and for charging battery.
    2. High-frequency pulse-width-modulation (PWM) design, using Insulated Gate Bi-polar Transistors (IGBTs).
    3. Modular design for easy replacement.

4. Rectifier capable of drawing power from utility with a power factor of 0.99 under nominal conditions.
  5. Rectifier protection circuitry prevents IGBTs from sourcing current in excess of their published ratings.
2. Inverter:
  1. Inverter is IGBT PWM design with high speed switching.
  2. Provides specified quality output power while operating from any DC source voltage (rectifier or battery) within specified DC operating range.
  3. Protection circuitry that prevents IGBTs from sourcing current in excess of their published ratings.
7. Static Bypass:
  1. Alternative source of power for critical load when abnormal condition prevents operation in normal mode.
  2. Fully rated, continuous duty, naturally commutated static switch for high-speed transfers.
  3. Transfers to bypass (for stand alone, and parallel capacity systems) automatically initiated for following conditions:
    1. output overload period expired;
    2. critical bus voltage out of limits;
    3. internal over temperature period expired;
    4. total battery discharge;
    5. UPS failure.
  4. Uninterrupted automatic re-transfer occurs whenever inverter(s) can assume critical load.
  5. Uninterrupted automatic re-transfers are inhibited for following conditions:
    1. when transfer to bypass is activated manually or remotely;
    2. in event of multiple transfers/re-transfer operations control circuitry limits "cycling" to three operations in any ten-minute period; third transfer locks critical load on bypass source, for 60 minutes;
    3. UPS failure.
  6. Uninterrupted manual transfers are initiated from control panel, and transfers to bypass and from bypass is possible with inverter logic. During manual transfers to bypass mode, inverter must verify proper bypass operations before transferring critical load to bypass.
  7. Transfers to bypass are inhibited for following conditions:
    1. bypass voltage out of limits (+10%, to -10% of nominal);
    2. bypass frequency out of limits (+/- 4 Hz, adjustable, factory set);
    3. bypass out of synchronization;
    4. bypass phase rotation / installation error.
  8. Static transfer time: No break, complete in less than 4 ms.
  9. Bypass manually energized using control panel or remotely through building alarm input.
8. Monitoring and Control Components:
  1. Control panel provides fully automatic operation of through microprocessor controlled digital signal processing. Start-up and transfers are automatic functions, and do not require operator intervention.
  2. System software to provide control, monitoring and communication requirements of UPS unit and batteries. System software to be compatible for use by wide range of operating systems.
  3. 178 mm (7") touch sensitive, backlit LCD front panel display that includes LED indicators for basic UPS status. Colour coded LED vertical bars show UPS status (green, amber, red).
  4. LCD Displays:

1. UPS status (home screen): shows UPS status output voltage and battery time remaining, load level, average efficiency, power consumption in kWh, system mimic diagram, operating mode, and active events.
  2. Controls Tab: touch sensitive button controls, for turning UPS on and off, transfer to/from bypass, enabling or disabling battery charger, initiating battery test, and enabling or disabling Energy Saver System.
  3. Metering Tab: screen shows voltages currents, temperatures, kW, kVA, and power factor (as applicable) for UPS input, output, bypass source, and battery; colour coded (green, amber, red) bar graph indicators accompany power and temperature measurements.
  4. Logs Tab: alarm/event queue, active alarms and alarm history, events, status changes and commands, all timed to 1/1000<sup>th</sup> second for tracking and analysis;
  5. Statistics Tab: Numerically and graphically displays estimated savings afforded by energy saver operation over time.
  6. Settings Tab: Button access to user adjustable settings such as, but not limited to: date/time, building alarm designations, communications parameter setup, UPS name, user passwords, and display language.
5. Control Panel Lamp Indicators:
1. NORMAL: Green LED indicates that commercial AC utility or generator source is supplying power to rectifier and inverter is supporting critical load.
  2. BYPASS: Amber LED indicates that UPS has transferred load to bypass circuit.
  3. BATTERY: Amber LED indicates that commercial AC utility or generator source has failed and battery is supplying power to inverter, which is supporting load.
  4. ALARM: Red LED and accompanying audible alarm horn, indicates that UPS detects an alarm condition, outlined in detail in Logs tab from home screen and in operator's manual.
6. Interface Panel: Provides following signals and communication features:
1. Alarm Contact: Dry contact for annunciating summary alarm for user use.
  2. RS232 (EIA / TIA-232) and USB communications interfaces.
  3. Building Alarms: Five Inputs for monitoring status of external dry contacts.
  4. External REPO Contacts: To connect an external remote emergency power off switch to shut down UPS and de-energize critical load.
  5. Battery Control Contacts: To connect battery shunt trip and auxiliary contact signals from battery breaker or battery disconnect switch.
  6. External Bypass Indicator Connection: To acknowledge that external maintenance bypass has been closed around UPS, placing critical load on utility power.
7. Communications: UPS to be equipped with field configurable communications to allow for remote monitoring functions via plug-in devices. Include for:
1. Remote Monitoring:
    1. WEB/SNMP communication.
    2. Communications devices capable of communicating via various industry standard protocols such as RS232, SNMP, BACnet and ModBus.
    3. Monitoring of UPS status through isolated dry contact Form C relays; include minimum 2 NC and 2 NO contacts for auxiliary functions.
    4. Relay Card: Serial dry contact card providing 4 isolated dry output contacts, 1 isolated input; relays are programmable.
    5. Integrate into any industry standard Building Automation System (BAS); exact protocol requirements to be compatible with BAS serving building and confirmed with Mechanical Division BAS vendor.
    6. Monitored via any standard Internet browser (i.e. Internet Explorer and Netscape).
    7. Interfaces are hot swappable.



2. Shutdown:
  1. Orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS.
  2. Performed via in-network or out-of-network means.
  3. Order of shutdown user-defined, allowing maximization of runtime on battery for more critical systems.
  4. Capable of interfacing with an operating system's built-in shutdown routine.
3. Notification:
  1. Send alerts to key personnel via email or SNMP traps.
  2. Alarm notification may also be sent by a network message.
9. UPS Module Protection:
  1. Rectifier/Charger and Bypass protection provided through individual fusing of each phase.
  2. kAIC Rating: typically, 65 kAIC for up to 40 kW frame, and 100 kAIC for greater than 40 kW frames.
  3. Battery protection provided by thermal-magnetic molded-case circuit breakers in each battery cabinet (if standard battery pack is provided) or external protective device for an external battery.
  4. Electronic current limiting circuitry and fuses in inverter circuit provides output protection.
10. UPS Integral Battery Management System:
  1. Provides battery time remaining while operating in normal mode and battery mode. Battery time available information displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information available.
  2. Automatically tests battery system to ensure that battery can provide greater than 80% of its rated capacity. Testing batteries to not jeopardize operation of critical load. Upon detection of battery string(s) not capable of providing 80%, UPS system to alarm that battery needs attention/replacement. Battery test to detect following:
    1. open battery string;
    2. shorted battery string (current limit);
    3. battery capacity (runtime) less than 80% of "new" battery capacity.
11. Transformers:
  1. Where transformers are required to transform voltages to required levels, ensure that dimensions of entire assembly can be accommodated in available spaces of installation location. Review with Consultant prior to ordering.
12. Lithium Ion Batteries:
  1. UPS module to use lithium ion (Li-ion) batteries designed for auxiliary power service in UPS application. Primary battery to be furnished with impact resistant plastic cases.
  2. Battery pack: factory preassembled and prewired, sealed, maintenance-free, lightweight, compact, long-life Li-ion type batteries to provide power for at least 12 minutes at full load rating capacity of UPS; to support load during loss of input power to rectifier; li-ion battery solution operating temperature rating to be 0 - 45°C (32 - 113°F).
  3. Battery Cabinet:
    1. Requires front access only for installation, service and maintenance.
    2. Includes DC rated circuit breaker to only provide protection to battery string within that battery cabinet.
    3. External battery cabinet to match depth, height and appearance of UPS cabinet. Power and control wiring between cabinets to be factory provided.
    4. Refer to additional cabinet requirements later in this Section.
  4. Battery Monitoring:

1. Battery monitoring provided at module, rack, and system level Switched-mode power supply included to provide power for battery monitoring system.
2. Communicates with UPS via dry contact.
5. Safety Device and Level of Protection:
  1. System designed with highest level of protection built into battery system against 2 potential safety risks – over voltage and short circuit. Consists of 3 level of protection namely, cell, module and rack level.
  2. 1st Level Protection - Battery management system and switch gear: Each battery rack is installed with main switch gear to isolate affected battery rack in event of a fault. Battery management system included in each rack to provide continuous monitoring of voltage and temperature of each cell within rack. Battery management system gathers and analyses rack current. In event of over voltage or short circuit, Battery management system trips breaker at rack level.
  3. 2nd Level Protection - Fuse: Fuses are built into main switch gear at rack level. In event of a fault current (caused by short circuit) which breaker cannot be activated in shortest time, fuses to be activated to clear fault current without damaging cells.
  4. Protection - Cell: Several protection features incorporated into cell namely, safety function layer, multi-layers separator, safety vent, safety fuse and overcharged safety device. These safety features are to protect cell from overcharging and thermal runaway.
13. Enclosures/Cabinets:
  1. Entire UPS system including accessories, transformer, maintenance bypass, and battery packs to be provided in matching dead front, free standing, and enamelled painted steel enclosures. Enclosures include safety shields behind doors and equipped with casters and leveling feet. Front doors include locks to prevent unauthorized entry.
  2. Enclosures to be suitably forced air fan ventilated and NEMA 1 rated with sprinkler-proof provisions including drip shield. Drip shield to be constructed of steel and finished to match UPS. Drip shield to be manufactured by UPS manufacturer. Ventilation louvres to be designed to prevent penetration of water spray from activated sprinklers onto live parts, and doors and component openings to be gasketed.
  3. No back or side clearance or access to be required for system. Serviceable subassemblies to be modular and capable of being replaced from front of UPS. Back and side enclosure covers to be capable of being located directly adjacent to a wall.
  4. Cable entries provisions provided to suit specific project installation requirements.
14. Additional Requirements:
  1. External wrap around maintenance by-pass:
    1. Multi-breaker manual maintenance bypass switch to isolate UPS module from commercial AC input and critical load; switch provides complete isolation of UPS for servicing.
    2. Switch is 3-position make before break switch, "NORMAL," "FULL BYPASS" and "SERVICE", interlocked between UPS and bypass to prohibit improper operation.
    3. Includes hardware and interconnecting cable for connection to UPS module.
    4. Installed in integrated matching cabinet to UPS cabinet.
  2. Output Breakers: As shown on drawings and as required.
  3. Spare Parts: Manufacturer's recommended spare parts kit including one modular logic board of each type of replaceable logic board.
  4. Remote Annunciator Panel: Panel with 8 backlit status indicator lamps, identification labeling, audible horn, power supply and backbox.
  5. Integrated Cabinets with following:
    1. external maintenance bypass;
    2. isolation transformer;

15. Warranty:
  1. UPS System:
    1. UPS manufacturer to warrant UPS system against defects in materials and workmanship for 24 months from date of substantial completion. Warranty to include all labour and materials with no deductible amounts.
  2. Batteries:
    1. System manufacturer to provide full comprehensive warranty on batteries against defects in materials and workmanship as follows:
      1. VRLA batteries to be designed for minimum 5 years of service life;
      2. Li-ion batteries to be designed for minimum 10 years of service life;
      3. batteries to be complete with 24 months full exchange and 60 months prorated warranty, from date of substantial completion;
      4. after 60 months, battery manufacturer's standard warranty to be passed through to Owner;
      5. batteries to be supplied by UPS manufacturer or UPS manufacturer authorized dealer.
16. Testing, Start-up, Verification and Training:
  1. Manufacturer to provide standard factory testing and submit copy of detailed reports to Consultant for review.
  2. Manufacturer's authorized technician to:
    1. provide onsite service of inspecting installation, perform start-up, testing and verification of equipment;
    2. to assist installing Contractor in installation and testing of equipment; coordination of work with Contractor;
    3. preparation and signing certification report letter that states system has passed manufacturer's testing and performs to manufacturer's requirements for application;
    4. be present to assist during third party testing;
    5. provide instructions on system operating and maintenance.
  3. Perform testing and verification work at times acceptable to Owner and reviewed with Consultant.
  4. Refer to Part 3 for additional requirements.
17. Acceptable Manufacturers are:
  1. Eaton;
  2. Vertiv;
  3. Schneider MGE/APC;
  4. Mitsubishi.

### **3 Execution**

#### **3.1 INSTALLATION OF UPS UNITS**

1. Obtain required training from manufacturer's representative on any special installation procedures. Install units in accordance with manufacturer's instructions to suit specific installation requirements.
2. Provide specified UPS units for equipment applications as detailed and as sized in specifications and/or on drawings. Place units on concrete pads where required, level and secure in position. Provide seismic restraints as required by local governing codes.
3. Connect units in accordance with applicable Codes of authorities having jurisdiction and in accordance with manufacturer's instructions. Ensure adequate clearance is provided as per local governing code requirements and as required for access for operation and maintenance.

4. Coordinate feed entries and exits to suit site conditions and equipment locations.
5. Provide separate circuit to feed external maintenance bypass, as required.
6. Provide EPO operator on recessed wall box in locations as reviewed with Consultant. Provide wiring in conduit and connect to UPS unit. Provide engraved nameplate identifying operator.
7. Review communication interfaces with Consultant and BAS vendor. Provide alarm/communications circuits as required. Include for provision of conduits, boxes and control/signal wiring for interconnection to BAS. Coordinate with Mechanical Divisions BAS Contractor on location of BAS panel to be used for monitoring points and extend wiring in conduit from electrical equipment to location. Terminate in junction box leaving 3 m (10') of slack length of wiring (exact length to be coordinated between Mechanical and Electrical trades), for extending and termination to BAS panel by Mechanical Division BAS Contractor. Properly identify wiring and junction box.
8. Materials and parts comprising UPS units to be new, of current manufacture, of a high grade and free from defects and imperfections and must have been in prior service, except as required during factory testing.
9. Provide transparent plastic covers of suitable gauge during installation of large UPS unit to protect entire UPS equipment from dust and dirt during Project Work.
10. Wiring and bolted connections of bus bars, lugs, and cables to be made in accordance with requirements of system manufacturer and applicable governing codes and standards. Electrical power connections to be torqued to required value and marked.
11. Protect wire runs in a manner which separates power and control wiring. Make provisions in cabinets to permit installation of input and output cabling, using raceway or conduit.
12. Where custom painting is specified, clean, prime, and paint UPS cabinets. Select colour from manufacturer's standard colour selection. Review finish with Consultant prior to ordering.
13. Provide drip shield for UPS units located in equipment rooms or other unfinished areas.
14. Ground and bond equipment as per local electrical code requirements, to suit specific project requirements.
15. Provide adequate ventilation to ensure that components are operated within their environmental ratings.
16. Nameplates:
  1. Provide engraved lamaroid nameplates for equipment and components.
  2. Prior to manufacture of nameplates, review nomenclature with Consultant in writing.
  3. During installation onsite, provide temporary labelling until permanent nameplates are installed.
17. Where required, provide local governing electrical inspection authority approvals of power supply work.

### **3.2 INSPECTION, TESTING, START-UP, COMMISSIONING AND VERIFICATION WORK**

1. Include for onsite inspection, testing, start-up, commissioning and verification by manufacturer's field service personnel. Arrange for testing and commissioning to be performed by equipment supplier and witnessed by Consultant and Owner at time approved by Owner and reviewed with Consultant.
2. Under direction of Consultant, carry out complete performance acceptance tests and associated work at site on installed UPS units. Include for provision of full capacity load banks for testing. Manufacturer to provide monitoring equipment required to demonstrate successful operation.
3. Tests to be conducted without disturbing user wiring and completed prior to connection of site critical loads.

4. Perform visual inspection, mechanical inspection, electrical inspection, start-up and verification, including but not limited to:
  1. inspect equipment for damage and for proper installation;
  2. perform start-up procedure as per manufacturer's instructions and recommendations;
  3. test entire UPS system for automatic operation; testing must show successful uninterrupted full load transfer upon hydro failure to UPS and uninterrupted transfer from UPS to bypass;
  4. perform load testing, battery system testing, bypass test, and integrated testing with transfer switches and breakers feeding UPS unit and external bypass.
  5. inspect and test batteries for charge and charging capability;
  6. Inspect batteries for correct connections;
  7. test for low battery shut down;
  8. test battery monitoring system;
  9. test external maintenance bypass switch;
  10. load test for connected building load, and automatic operation of normal power failure; simulate power failure and power retransfer; simulate power failure of emergency generators and reconnection;
  11. testing to include use of artificial load bank with tests as follows:
    1. continuous test for 4 hours at full load;
    2. discharge batteries at full load for 15 minutes;
    3. recharge batteries for 60 minutes;
    4. supply full load.
  12. testing after installation to ensure IEEE 519 Harmonic levels are maintained at 100% and 50% load input and output;
  13. testing and demonstrating successful operation of EPO system;
  14. test system options and features to ensure proper operation.
5. Onsite testing to include but not be limited to following detailed parameters:
  1. recording functional alarms and voltage levels at which alarm occurs, on UPS system;
  2. recording critical load alarms and voltage levels at which alarm occurs, on UPS system;
  3. recording minimum and maximum adjustment of voltage potentiometer on system;
  4. recording levels and checking functionality of battery equalize feature;
  5. recording load testing data with 0%, 50% and 100% load for function of input VAC/IAC/THD%, VDC/IDC (charging), output VAC/ $\Phi$ - $\Phi$ V average/IAC, output kW/kVA/Hz and output voltage THD%;
  6. determine voltage regulation from 0-100% full load;
  7. determine voltage unbalance of system at 0%, 50% and 100% kW load;
  8. record transient response of system under load steps of 0-50%, 50-0%, 50-100%, 100-50%, 100% (UPS to bypass), 100% (bypass to UPS) and 100% simulated fuse failure; load percentages; Refer to kW rating of unit; record 3-phases of output voltage, 1-phase of output current and one phase of input voltage; attach printouts with report;
  9. perform battery discharge test; record battery details, specifications and operating data; load system to 100% kW load and record DCV and DCA at one-minute intervals from 0 to 20 minutes, record 3-phases of output voltage, one phase of output current and one phase of input voltage; attach printouts with report;
  10. record voltage levels and times at which Battery Discharge/Low Battery Warning/Low Battery Shutdown occur during discharge test;
  11. during battery charge (no load), record battery current limit (ADC, 10%) and reduced battery current limit (ADC, 1%);
  12. after battery recharge current has reached 0 A following battery capacity test, perform 125% overload test and verify/record overload alarm, input current limit (115%), reduced input current limit (100%), overload transfer alarm, auto-retransfer primed alarm and auto-retransfer successful (no alarm).

6. Rectify deficiencies to satisfaction of Owner.
7. Document, sign, and date test results. Submit minimum one bound hard copy and electronic copy to Consultant for review.

### **3.3 TRAINING**

1. Manufacturer's trained technician to perform onsite training of each user (including provision of user guides) prior to project completion to ensure that users are properly trained in the operation and maintenances of system.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.

## 2 Products

### 2.1 AUTOMATIC TRANSFER SWITCHES

1. ASCO, 7000 Series CSA approved, automatic transfer switch (ATS), double-throw, electrically operated, open transition, mechanically held, fully protected, complete with voltage sensing relays, a manual transfer facility incorporating spring handles, current ratings as indicated, arc chutes, magnetic blow-out coils and components necessary to provide proper performance and operation. Automatic transfer and bypass isolation switch to conform to CSA requirements including latest edition of CSA Standard, C22.2 No. 178, "Automatic Transfer Switches" and be sized on drawings.
2. ATS/BPS to be of withstand current ratings meeting available short circuit currents at location of each transfer switch as determined by electrical distribution system short circuit calculations and coordination study prepared as part of scope of Work. If at time of pricing such information is not identified in issued documents, allow in pricing for transfer switch withstand current rating to at least be equal to larger of normal or emergency side upstream overcurrent protective device rating.
3. ATS/BPS to be provided to manually permit convenient electrical bypass and isolation of automatic transfer that could not otherwise be tested and maintained without interrupting load. Bypass of load to either normal and emergency power source with complete isolation of automatic transfer switch to be possible regardless of status of automatic transfer switch. Bypass isolation to permit proper operation by one (1) person through movement of a maximum of two (2) handles at a common dead front panel. Entire system to consist of two (2) elements, automatic transfer switch and bypass-isolation switch, which is to be furnished completely factory interconnected and tested.
4. ATS to consist of a power transfer module and a control module, interconnected to provide complete automatic operation. Automatic transfer switch to be mechanically held and electrically operated by a single solenoid mechanism energized from source to which load is to be transferred. Switch to be rated for continuous duty and be inherently double throw. Switch to be mechanically interlocked to ensure only one (1) of two (2) possible positions - normal or emergency. Automatic transfer switch to be suitable for use with emergency sources such as an engine or turbine driven generator source or another utility source.
5. 7000 series control panel consists of a digital microprocessor controller with LCD display. Panel to be supplied with a protective cover and be mounted separately from transfer switch for ease of maintenance. Interconnecting wiring harness to include a keyed disconnect plug to enable control panel to be disconnected from transfer switch for routine maintenance. Sensing and control logic to be provided on printed circuit boards. Interfacing relays to be industrial grade plug-in type with dust covers.
6. Main contacts to transfer in 70 milliseconds or less and to be protected by separate arcing contacts with arc barriers between poles. Inspection of contacts (movable and stationary) and coils to be possible from front of switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle to be provided for maintenance purposes. Handle to permit operator to stop contacts at any point throughout entire travel to properly inspect and service contacts when required.
7. ATS/BPS utilizing components of moulded case circuit breakers, contactors, or parts thereof which have not been intended for continuous duty or repetitive load transfer switching are not acceptable.

8. Sensing and control logic panel to utilize solid-state sensing to initiate emergency mode of operation upon reduction of normal source to below 90% of nominal voltage and retransfer to normal when normal source restores to 90% and above of nominal. Pick-up voltage to be adjustable from 85%-100% of nominal and dropout voltage to be adjustable from 75%-98% of pick-up value.
9. ATS to be complete with following features:
  1. components and accessories typically removable from front for ease of service; pilot lights, selector switches and other controls typically mounted on "front" door of enclosure; ATS connections typically made from front;
  2. time delay one (1) to override momentary normal source outages to delay transfer switch and engine starting signals; adjustable from 0.5-6 seconds and initially set at 1 second;
  3. time delay (2B) for controlled time of load transfer to emergency; adjustable from 0-8 minutes and initially set at 0 minutes;
  4. time delay (2E for unloaded running time delay for emergency generator cool-down; adjustable from 0-30 minutes and initially set at 5 minutes;
  5. time delay (3A) on retransfer to normal source set to automatically by-pass if emergency source fails and normal source is available; adjustable from 0-30 minutes and initially set at 5 minutes;
  6. an engine start contact which closes on normal power failure to initiate engine start-up; where multiple start-up signals are required, include suitable relay module;
  7. accessory 17A, for preferred source selection;
  8. selector switches to perform "TEST", "AUTO", "RESET", "MANUAL (or OFF)" and "ENGINE START" functions;
  9. pilot lights (P/L) to indicate switch positions;
  10. suitable connections for conductors specified;
  11. frequency relay to prevent emergency load transfer until frequency of emergency source has reached its set value;
  12. in-phase monitoring of motor load with generator for transfer from normal to emergency and vice versa, by means of a monitor to sample relative phase angle and frequency different and to signal transfer switch to close when two (2) voltages are at required phase angle;
  13. two-way bypass isolation switch to permit load to be connected to either normal or emergency source, to permit transfer switch to be removed from service without power feedback to transfer switch connections, and to provide a transfer test position to enable testing transfer switch operation under no load conditions;
  14. overlapping neutral contacts as required;
  15. auxiliary contacts as required to operate connected systems such as alarms, with provision of at least two (2) normally open and two (2) normally closed auxiliary contacts;
  16. indicators to show switch position;
  17. momentary contact switch to allow built-in time delay on retransfer to normal to be bypassed;
  18. pilot light to illuminate when load is connected to emergency source;
  19. engraved Lamacoid nameplates identifying switch and components.
10. ATS supplying power for elevators to be equipped with a selective load disconnect and time delay control circuit to inhibit transfer for a pre-set amount of time to allow elevator controls to sense contact position of transfer switch to program itself to accommodate up-coming transfer. (ASCO accessory No. 31 Z).
11. ATS enclosures to be dead front access, free standing enamelled steel, minimum NEMA 1 cubicle with sprinkler protection provisions including drip shield, ventilation louvers designed to protect live components from water spray from activated sprinklers and gasketed doors and openings. Units to be finished in ANSI grey enamel.



12. Include for manufacturer's authorized representative to provide after installation onsite inspection, testing, start-up, verification, and user training of transfer switches.
13. Acceptable manufacturers are:
  1. ASCO;
  2. Cummins Onan;
  3. Caterpillar;
  4. Eaton Electric.

### **3 Execution**

#### **3.1 ATS FACTORY TESTING**

1. Perform standard factory tests outlined below on ATS equipment provided under this section. Perform tests in accordance with CSA, UL and NEMA standards.
2. Check insulation to ensure integrity of insulation and continuity of entire system.
3. Visually inspect to ensure that switch matches specification requirements and to verify that fit and finish meet quality standards.
4. Perform mechanical tests to verify that switch power sections are free of mechanical hindrances.
5. Perform electrical tests to verify complete electrical operation of switch and to set up time delays and voltage sensing settings of logic.
6. Provide certified copy of factory test reports to Consultant.
7. ATS to include label indicating order number, catalog number and date of testing.

#### **3.2 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES**

1. Provide transfer switches as required for each application. Refer to drawings for transfer switch ratings and mounting locations. Advise transfer switch manufacturer of coordination study available fault current results to ensure transfer switches are provided of withstand current rating meeting available fault current at location of each transfer switch. Where initial pricing requirements included for ratings exceeding final coordination study findings, advise Consultant.
2. Install in accordance with manufacturer's instructions to suit specific applications. Mount stand-alone units to concrete bases. Provide seismic restraints as required. Ensure adequate clearance is provided as per code requirements and as required for access for operation and maintenance. Connect complete.
3. Obtain required training from manufacturer's representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.
4. Where required in emergency power distribution system connected to gensets, provide wiring in conduit from genset control panel to appropriate transfer switches contacts to initialise engine start-up upon loss of normal power and provide signals to transfer switches to initiate appropriate operations. Provide MI fire rated conductors to transfer switches used for life safety applications. Where load banks are connected to genset control system during testing, include for required interconnection wiring in conduit for loss of normal power signal to load bank controllers to initiate dropping load bank to pick-up essential building loads.
5. Review electrical systems, fire alarm system, building automation system and elevator requirements with respective equipment vendors and coordinate required power, monitoring and control interconnections. Provide required contacts, relays and wiring in conduit between system equipment allowing for respective system equipment trades to make final connections to their own equipment. Provide MI fire rated conductors to equipment used for life safety applications and for applications required by local governing authorities and codes.

6. Comply with applicable CSA standards with regards to provision of remote audible and visual safety indicators for both automatic and bypass modes.
7. Ground and bond switches as per local electrical code requirements. Refer also to requirements of grounding and bonding Section.
8. When installation is complete, arrange for system manufacturer authorized technician to visit site to inspect installation, perform testing and start-up procedures, and certify system. In presence of Consultant, perform a complete operational test of system to ensure that system operates satisfactorily under operating conditions specified.
9. Coordinate transfer switch testing with engine-generator set testing to ensure that complete emergency power plant operates correctly. Adjust as required.
10. Arrange for manufacturer to provide a letter certifying compliance with requirements of this Specification. Certification to identify, by serial number(s), equipment involved.
11. Provide engraved Lamacoid nameplates with nomenclature reviewed with Consultant.
12. Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

**END OF SECTION**

## 1 General

### 1.1 SUBMITTALS

1. Submit shop drawings for products specified in this Section.

## 2 Products

### 2.1 SURGE PROTECTIVE DEVICES

1. Switchgear / switchboards to be complete with integral surge protective devices (SPDs). Unit to be factory installed into separate cubicle section and connected onto bussing through integral disconnect as recommended by manufacturer. SPD features include following:
  1. in accordance with ANSI/UL 1449 3rd Edition, IEEE C62.41, C62.45, UL 1283, and CSA Standards;
  2. Type 1;
  3. maximum voltage protection rating to not exceed 700 V (120/208 V) or 1500 V (600/347V): L-N, L-G, N-G; 1200 V (120/208 V) or 3000 V (600V): L-L;
  4. minimum nominal discharge current rating of 10 kA;
  5. minimum short circuit current rating of 100 kA;
  6. peak surge current 250 KA per phase;
  7. high-performance EMI/RFI noise rejection filter;
  8. indicator LED on units to identify protection integrity status of metal-oxide varistors; indicator to be visible on front of switchgear/switchboard;
  9. diagnostic package with status indicators on each phase;
  10. LCD surge counter display;
  11. audible alarm with silence button;
  12. Form C alarm contacts;
  13. maintenance free and not require any user intervention throughout its life;
  14. standard manufacturer's minimum 5 years parts and labour warranty.
2. Distribution panelboards as scheduled to be complete with integral surge protective devices (SPDs). Unit to be factory installed and connected onto bussing through integral disconnect/breaker as recommended by manufacturer. SPD features include:
  1. in accordance with ANSI/UL 1449 3rd Edition, IEEE C62.41, C62.45, UL 1283, and CSA Standards;
  2. Type 1;
  3. maximum voltage protection rating to not exceed 700 V (120/208 V) or 1500 V (600/347V): L-N, L-G, N-G; 1200 V (120/208 V) or 3000 V (600V): L-L;
  4. minimum nominal discharge current rating of 10 kA;
  5. minimum short circuit current rating of 100 kA;
  6. peak surge current 150 KA per phase;
  7. indicator LED on units to identify protection integrity status of metal-oxide varistors; indicator to be visible on front of panelboard;
  8. high-performance EMI/RFI noise rejection filter;
  9. indicator LED on units to identify protection integrity status of MOVs; indicator to be visible on front of switchgear/switchboard;
  10. diagnostic package with status indicators on each phase;
  11. audible alarm;
  12. Form C alarm contacts;
  13. maintenance free and not require any user intervention throughout its life;
  14. standard manufacturer's minimum 5 years parts and labour warranty.
3. Branch circuit panelboards as scheduled to be complete with integral surge protective devices (SPDs). Unit to be factory installed and connected onto bussing through integral disconnect/breaker as recommended by manufacturer. SPD features include:

1. in accordance with ANSI/UL 1449 3rd Edition, IEEE C62.41, C62.45, UL 1283, and CSA Standards;
2. Type 1;
3. maximum voltage protection rating to not exceed 700 V (120/208 V) (L-N, L-G, N-G);
4. minimum nominal discharge current rating of 10 kA;
5. minimum short circuit current rating of 100 kA;
6. minimum peak surge current 100 KA per phase;
7. high-performance EMI/RFI noise rejection filter;
8. indicator LED on units to identify protection integrity status of metal-oxide varistors; indicator to be visible on front of panelboards;
9. diagnostic package with status indicators on each phase;
10. audible alarm;
11. Form C alarm contacts;
12. maintenance free and not require any user intervention throughout its life;
13. standard manufacturer's minimum 5 years parts and labour warranty.

## 2.2 MANUFACTURERS

1. Acceptable Manufacturers:
  1. Eaton Electric;
  2. Schneider Electric;
  3. Siemens Electric;
  4. APT (Advanced Protection Technologies).

## 3 Execution

### 3.1 INSTALLATION OF SPD UNITS

1. Obtain required training from manufacturer's representative on any special installation procedures. Install units in accordance with manufacturer's instructions to suit specific installation requirements.
2. Coordinate switchgear / switchboard configuration to accommodate dedicated cell to install SPD units for applications of integral mounting. Install dedicated disconnect/breaker device of type and rating in accordance with SPD manufacturer's requirements. Connect complete to SPD and bussing.
3. Ensure that MOV condition LED indicator is visible from front of board/panel.
4. Connect and make necessary incoming and outgoing power cable connections to equipment in strict accordance with equipment manufacturer's recommendations.
5. Ground and bond components as per local electrical code requirements. Refer also to requirements of grounding and bonding article.
6. Provide alarm/communications circuits as required. Include for provision of conduits, boxes and control/signal wiring for interconnection to BAS. Coordinate with Mechanical Divisions BAS Contractor on location of BAS panel to be used for monitoring points and extend wiring in conduit from SPD to location. Terminate in junction box leaving 3 m (10') of slack length of wiring (exact length to be coordinated between Mechanical and Electrical trades), for extending and termination to BAS panel by Mechanical Division BAS Contractor. Properly identify wiring and junction box.
7. Manufacturer representative to assist installing Contractor in installation of equipment, testing equipment, performing start-up and verification of equipment.
8. Be present to assist during third party testing.
9. Perform testing at times reviewed with Consultant.

10. Provide instructions on system operating and maintenance.
11. Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

**END OF SECTION**

## 1 General

### 1.1 REFERENCE STANDARDS

1. The following is a list of standards which may be referenced in this Section:
  1. Institute of Electrical and Electronic Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
  2. Canadian Standards Association CSA C22.1 No. 141 Unit Equipment for Emergency Lighting.
  3. Certified Ballast Manufacturer (CBM).
  4. Federal Communications Commission (FCC).
  5. Illuminating Engineering Society of North America (IESNA).
  6. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
  7. American National Standards Institute (ANSI)
    1. ANSI C78.377-2008 Specifications for the Chromaticity of Solid State Lighting Products;
    2. ANSI C 82.77-2002 Harmonic Emission Limits – Related Power Quality Requirements for Lighting.
    3. American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE )
    4. ANSI C62.41.1-2002 – IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits.
    5. ANSI C62.41.2-2002 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000W and less) AC Power Circuits.
    6. ANSI C82.SSL1 – SSL Drivers;
    7. ANSI C82.77-2002 Harmonic Emission Limits
  8. Illuminating Engineering Society (IES).
    1. G-2-10 Guideline for the Application of General Illumination (“White”) Light-Emitting Diode (LED) Technologies;
    2. LM-79-08 Approved Method: Electrical and Photometric Testing of Solid-State Lighting Devices;
    3. LM-80-08 Approved Method: Measuring Lumen Depreciation of LED Light Sources;
    4. LM-82-12 Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature;
    5. RP-16-10 Nomenclature and Definitions for Illuminating Engineering;
    6. TM-16-05 Light Emitting Diode (LED) Sources and Systems;
    7. TM-21 -11 Projecting Long Term Lumen Maintenance of LED Light Sources.
  9. Canadian Standards Association (CSA International)
    1. CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
    2. CSA C22.2, General Requirements – Canadian Electrical Code Part II.
    3. CSA C22.2 No.141-15, Unit Equipment for Emergency Lighting. CSA C68.3 Power Cables with Thermoset Insulation.
    4. CSA C860-11, Performance of Internally-Lighted Exit Signs. CSA C21.2 300 V Control Cable.
    5. National Fire Protection Association (NFPA)
      1. NFPA 101-2006, Life Safety Code IEEE 848 Standard Procedure for the Determination of the Ampacity Derating of Fire-Protected Cables
    6. National Building Code of Canada 2015(NBC)

10. National Electrical Manufacturers Association (NEMA)
  1. SSL-1-2010 Electronic Drivers for LED Devices, Arrays, or Systems;
  2. SSL-3-2010 High-Power White LED Binning for General Illumination.
11. Underwriters Laboratories, Inc. (ULC):
12. NFPA No. 101 Life Safety Code.
13. Ontario Electrical Safety Code.

## 1.2 SUBMITTALS

1. Submit shop drawings in accordance with Section 26 05 00 – Basic Electrical Materials and Methods, and the requirements of Division 1.
2. Where the Architect is to select colours and finish of lighting fixtures after award of Contract, it shall be the responsibility of the Contractor for Division 26 to obtain this information during the shop drawing submittal/review stage.
3. Action Submittals:
  1. Shop Drawings:
    1. Interior Luminaires:
      1. Catalogue data sheets and pictures.
      2. Luminaire finish and metal gauge.
      3. Lens material, pattern, and thickness.
      4. Driver data sheet with system efficacy.
      5. Candle power distribution curves in two or more planes.
      6. Candle power chart 0 to 90 degrees.
      7. Lumen output chart.
      8. Mounting details.
    2. Exterior Luminaires:
      1. Catalogue data sheets and pictures.
      2. Luminaire finish and metal gauge.
      3. Lens material, pattern, and thickness.
      4. Driver data sheet with system efficacy.
      5. IESNA lighting classification and isolux diagram.
      6. Fastening details to wall or pole.
      7. EPA ratings
      8. For light poles, submit wind loading, EPA ratings, complete dimensions, foundation details, anchoring details and finish.
  3. LED Chipsets:
    1. Colours.
    2. Approximate life (in hours) to L70 requirements.
    3. Approximate initial lumens.
    4. Lumen maintenance curve.
    5. CRI.
  4. Drivers:
    1. Type.
    2. Wiring diagram.
    3. Approximate life (in hours)
    4. Nominal watts and input watts.
    5. Input voltage and power factor.
    6. Starting current.
    7. Temperature rating.
    8. Efficacy ratings.

9. Low temperature characteristics.
5. Photo Time Control:
  1. Wiring diagram.
  2. Contact ratings.
6. Photocells:
  1. Voltage, and power consumption.
  2. Ampacity.
  3. Contacts and time delay.
  4. Operating levels.
  5. Enclosure type and dimensions.
  6. Mounting details
  7. Temperature range.
7. Occupancy Sensors:
  1. Type.
  2. Switching capacity.
  3. Coverage.
  4. Time delay AUTO/OFF adjustment.
  5. Mounting details
8. Low Voltage Remote Control Wiring System:
  1. Type.
  2. Switching capacity.
  3. Voltage rating.
  4. Wiring diagrams.

### 1.3 WARRANTY

1. All lighting systems components shall be supplied the manufacturer's standard warranty, a minimum one-year warranty.
2. Extended warranties shall be submitted within Operating and Maintenance manuals as detailed in Section 26 05 00 – Basic Electrical Material and Methods.

### 1.4 QUALITY ASSURANCE

1. Pre-installation Meeting:
  1. Occupancy Sensors: Arrange a pre-installation meeting with the manufacturer's factory authorized representative at the project site, to verify placement of sensors and installation criteria.
2. Extra Materials: Furnish, tag, and box for shipment and storage, the following spare parts:

Item	Quantity
LH1	Two complete units

### 1.5 DELIVERY, STORAGE AND HANDLING

1. Deliver, store and handle materials in accordance with Construction Quality Management Plan. Store in original cartons, in a dry and protected space.
2. Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
3. Packaging Waste Management: Remove for reuse and return by manufacturer of pallets, crates, packaging materials and padding in accordance with Section 01 74 21- Construction & Demo. Waste Management and Disposal.



4. Divert unused metal materials from landfill to metal recycling facility.
5. Disposal and recycling of fluorescent lamps as per local regulations.
6. Disposal of old PCB filled ballasts.

## **2 Products**

### **2.1 LUMINAIRES**

1. See the Lighting Fixture Schedule on the Drawings.
2. Wire Leads: Minimum 18 AWG.
3. Component Access: Accessible and replaceable without removing luminaire from ceiling.
4. Soffit Installations:
  1. ULC Labeled: SUITABLE FOR DAMP LOCATIONS.
  2. Driver: Removable, prewired.
5. Exterior Installations:
  1. ULC Labeled: SUITABLE FOR WET LOCATIONS.
  2. Driver: Removable, prewired.
  3. When factory installed photocells are provided, entire assembly shall have ULC label.

### **2.2 LED CHIPSETS**

1. See the Luminaire Schedule.

### **2.3 DRIVERS**

1. General:
  1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
  2. Certified by electrical testing laboratory to conform to CBM specifications.
  3. Power factor of 98 percent or greater.
  4. Driver lifespan shall exceed 100,000 hours.
  5. Total harmonic distortion (THD) shall be less than 5 percent.
  6. Shall withstand line transients per IEEE C62.41, Cat A.
  7. Driver shall start lamp at a minimum temperature of 10 degrees Celsius for indoor fixtures, and -30 degree Celsius for outdoor fixtures.
  8. Driver input voltage shall match luminaire input voltage. Use of separate internal matching transformers shall only be permitted if the lifespan of the transformer exceeds that of the driver. Submit transformer cut sheet information with driver submittal if that is considered as part of the luminaire.
  9. Dimming control shall be according to Luminaire Schedule.

### **2.4 SURGE PROTECTION FOR LED SYSTEMS**

1. Luminaire manufacturers supplying exterior LED luminaires are to include surge protection for LED systems in accordance with IEEE and ANSI C62.41.2 transient surge requirements. Surge protection to be level of 6 kV/3 kA for low exposure conditions (low grade level landscape lighting) and, 10 kV/10 kA for high exposure conditions (pole mounted lighting).

## **3 Execution**

### **3.1 LUMINAIRES**

1. General:
  1. Install in accordance with the manufacturer's recommendations.
  2. Provide proper hangers, pendants, and canopies as necessary for complete installation.

3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
  4. Install plumb and level.
  5. Mounting heights shown on the Drawings for pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
  6. Mounting heights shown on the Drawings for wall mounted luminaires are measured from center of mounting plate to finished floor or finished grade, whichever is applicable.
  7. Install each luminaire outlet box with galvanized stud.
  8. Verify weight and mounting method of all luminaires prior to ordering and provide suitable support. Coordinate with General Contractor for luminaires that require additional blocking or support. Luminaire mounting assemblies shall comply with all local seismic codes and regulations.
  9. Protective material to remain on luminaires until prior to commissioning. At commissioning, clean luminaires as in new condition.
  10. Do not daisy-chain light fixture wiring. Provide junction boxes and individual wiring to each light fixture.
  11. Avoid interference with, and provide clearance for, the equipment. Where the indicated locations for the lighting fixtures conflict with the locations for other equipment, change the locations for the lighting fixtures by the minimum distances necessary and as approved by the Consultant.
  12. Where fixtures are specified to have two separate power sources within, provide all necessary barriers, etc., to isolate the two power sources as per the requirements of the authorities having jurisdiction.
2. Pendant Mounted:
    1. Space single stem hangers or suspension cables, on continuous row luminaires as per manufacturer recommended specifications.
    2. Provide twin stem hangers or suspension cable, on single luminaires.
    3. Aircraft Cable Support shall use cable, anchorages, and intermediate supports recommended by luminaire manufacturer.
    4. Not all lighting appurtenances such as outlet box locations are shown on drawings. Position outlet boxes to coincide with suspension hangers and knockouts.
    5. For suspended lighting fixtures, provide the indicated mounting height clearances between the bottoms of the fixtures and the finished floors.
  3. Swinging Type: Provide, at each support, safety cable capable of supporting four times the vertical load from structure to luminaire.
    1. Brace suspended luminaires installed near ducts or other elements so that they do not swing into obstructions.
  4. Finished Areas:
    1. Install symmetrically with tile pattern.
    2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
    3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and trims.
    4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 38 mm from ceiling surface or use fixtures suitable for mounting on low density ceilings.
    5. Junction Boxes:
      1. Flush and Recessed Luminaires: Locate a minimum of 300 mm from luminaire.
      2. In concealed locations, install junction boxes to be accessible by removing luminaire.
      3. For remote mounted junction boxes, refer to luminaire schedule and drawings.
    6. Wiring and Conduit:
      1. Provide wiring of temperature rating required by luminaire.

2. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
  1. Provide each recessed luminaire with two safety chains or two No. 12 soft annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
  2. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
  3. Fasten chain or wire to each end of luminaire.
5. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.
  1. Fixture Suspension: Provide threaded steel hanger rods or wires. Scissor type hangers not permitted.
  2. Rod Hangers shall be 3/16-inch minimum diameter, cadmium-plated threaded steel rod.
  3. Wires shall be ASTM A641/A641M, Class 3, soft temper, zinc coated steel, 12 gauge.
  4. Wires for humid spaces shall be ASTM A 580/A 580M, composition 302 or 304, annealed stainless steel, 12 gauge.
  5. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.
  6. Hang independent of pipes and ducts.
6. Building Exterior: Flush mounted back box and concealed conduit, unless otherwise indicated in the Contract Documents.

### **3.2 LED CHIPSETS**

1. Provide in each fixture, number and type for which fixture is designed.

### **3.3 DRIVERS**

1. Factory installed by the fixture manufacturer.
2. Replace noisy or defective drivers.

### **3.4 LIGHTING CONTROL**

1. Refer to Lighting control specifications section 26 09 23 – Low Voltage Lighting Control Systems for controls sequence of operation on the contract drawings.

### **3.5 EXIT LIGHT**

1. Refer to Luminaire Schedule.
2. Install exit lights at locations indicated in the Contract Documents and as required.
3. Install wall mounted units 2250 mm above finished floor in office areas and 300 mm above doorway openings in other areas.
4. Feed from branch circuits dedicated to emergency lighting only. Refer to drawings.

### **3.6 TESTING**

1. The luminaires shall be properly tested with the lighting controls to ensure proper operation, zones, scenes, emergency operation, dusk/dawn signals, and other control settings.
2. Malfunctioning Luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly

### **3.7 CLEANING**

1. Remove labels and markings, except ULC or CSA listing mark.
2. Wipe luminaires inside and out to remove construction dust.

3. Clean luminaire plastic lenses with antistatic cleaners only.
4. Waste Management: Separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Construction Waste Management.
5. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
6. Replace defective components at time of Substantial Performance of the Work.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

1. Unless otherwise indicated, lighting fixture bodies shall be of minimum 20 gauge cold rolled prime steel of rigid construction with knockouts as required.
2. Any feature architectural luminaire, surface, or pendent mounted shall be manufactured from extruded aluminum.
3. Fixture rigidity shall permit any suspension method without sag. Fluorescent fixtures shall be suitable for either individual or continuous mounting.
4. Any luminaire requiring a continuous luminous appearance must be coordinated with the consultants prior to manufacturing. Consultants must provide custom specifications (lengths) to manufacturer. Luminaire shall be installed as a single "system."
5. Fixtures shall be finished in baked white enamel with exposed surfaces matching the exposed T-bar ceiling specified in other sections and shall resist chipping, corrosion, and discolouration. Before finishing, all metal shall be chemically degreased and neutralized. Finish shall not be less than two coats of enamel, sprayed and baked on. Reflecting surfaces shall be white with an average reflectance of not less than 85%.
6. Fixture lenses and diffusers shall be rigid enough to be self-supporting without sag, easily removable but not loose. Provide additional thickness of lens to prevent sag at no extra cost to the Owner.
7. Where the Architect is to select colours and finish of lighting fixtures after award of Contract, it shall be the responsibility of the Contractor for Division 26 to obtain this information during the shop drawing submittal/review stage.
8. Where fixtures are specified to have two separate power sources within, provide all necessary barriers, etc., to isolate the two power sources as per the requirements of the authorities having jurisdiction.

## **2 Products**

### **2.1 MATERIALS**

1. Refer to drawings and– Lighting Schedules

## **3 Execution**

### **3.1 INSTALLATION**

1. Any luminaire installed into a drywall ceiling must be accessible from below the ceiling for maintenance, including changing lamps, ballasts, LED modules, and LED drivers.
2. All LED luminaires shall be composed of modular components for future maintenance by building staff. This includes replaceable LED driver and LED (printed circuit board, LED light bar, or LED module.)
3. Any luminaire having a ridged lens shall be oriented where the ridge is on the interior of the luminaire and the exterior surface of the luminaire is smooth for ease of maintenance.

4. Any suspended indirect luminaire with an upright component shall be complete with a clear lens on top for ease of maintenance. Open top luminaires are not permitted.
5. All luminaires intended for use in exterior locations or wet interior locations shall be gasketed and CUL listed for wet locations.
6. All luminaires intended for use in exterior locations shall be liquid ingress protection (IP) rated at a minimum of IP65.
7. All luminaires intended for use in exterior locations shall be fused. Pole mounted luminaires are excluded from this requirement if a fuse kit is installed in an accessible hand well in the pole.
8. All exterior luminaires shall be constructed to emit zero light above the horizontal. Ensure the IES BUG Rating  $U = 0$ .
9. All Luminaires shall be installed accurately in line and level. Co-ordinate this work with other trades to ensure that their work is not held up by the work of this contract and that the luminaires are installed on schedule.
10. All luminaires shall be installed in the standard manner for the type of luminaire and in accordance with the manufacturer's instructions. Luminaire studs or other equally secure methods of attachment shall be used throughout or as called for in the Luminaire Schedule.
11. The Contractor shall be responsible for checking the ceilings finishes in all areas where recessed luminaires are being installed to ensure that the luminaires which are ordered for these areas are purchased with suitable ceiling trim for the particular ceiling finish. Luminaires which are sent to the site with the wrong ceiling trim or flanges shall be replaced with luminaires having the correct trims without additional cost to the Owner. The Contractor shall notify the Project Manager if the ceilings are improperly installed and shall be guided by his decisions before proceeding with the luminaire installation.
12. Plaster frames and rings shall be provided for luminaires recessed in plaster ceilings. The installation of the plaster ring shall be done by a Lathing Trade Contractor under the supervision of the Contactor for Division 26 to ensure that they are located correctly.
13. The Contractor for Division 26 shall include a dry wall mounting kit for any recessed luminaire installed in a drywall ceiling.
14. The Contractor for Division 26 shall coordinate the installation of any recessed luminaire labeled as 'flangeless' with the drywall contractor.
15. Luminaires shall be properly cleaned at the time of installation. Any luminaires showing marks or scratches due to handling or installation shall be replaced without additional cost to the Owner.
16. Luminaires in service areas, mechanical, and electrical rooms shall be installed after the mechanical and electrical equipment is in place. The fixtures shall be located on site to clear all obstructions and to facilitate lamp removal, to the approval of the Owner.
17. Luminaires and accessories shall not be fixed to or suspended in any way from mechanical pipes, ducts, or other components. If necessary, additional supports shall be installed to bridge the equipment.
18. All luminaires which are located in suspended ceilings shall be supported by approved wires or chains which will allow the luminaire to be supported properly and independent of the ceiling system. All supports shall be provided by this Contract.
19. Install reflector in coves per manufacturer's instructions.

20. Provide luminaire mock-ups as detailed in the luminaire schedule. No luminaire shall be put into manufacture until Consultants and Project Manager's approval is received. Coordinate time with Consultant and Owner to view mock-up.
21. Where luminaires are mounted on wiring channels or assemblies provide necessary barrier to isolate dual power sources.

**END OF SECTION**

## **1 General**

### **1.1 INTRODUCTION**

1. It is essential in today's installations to have a properly installed grounding and bonding system because of all the sensitive electronic components being connected together in a network.
2. A telecommunications grounding and bonding system consists of grounding busbars, bonding backbones, and other bonding conductors.
3. It provides a common ground reference for the telecommunications systems within the building and a common bonding system back to the main telecommunications room.
4. This Section specifies uniform telecommunications grounding and bonding infrastructure that shall be followed based on the ANSI/TIA-607-D standard.
5. If there are any questions, please contact the Owner Representative for clarification.

### **1.2 RELATED REQUIREMENTS**

1. Division 26 – Electrical:
  1. Section 26 05 00 – General Electrical Requirements
  2. Section 26 05 05 – Basic Materials and Methods

### **1.3 REFERENCE STANDARDS**

1. American National Standards Institute (ANSI)/Telecommunications Industries Association (TIA)
  1. ANSI/TIA-607-D, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
  2. ANSI/TIA-606-D, Administration Standard for Telecommunications Infrastructure.
2. Motorola R56 Standards and Guidelines for Communication Sites.
3. The Contractor shall perform all work according to Federal, Provincial, and Municipal codes, rules, regulations, and ordinances governing the work, and as fully part of the specifications as if herein repeated or hereto attached.
4. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.
5. If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Client's representative in writing.
6. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
7. In the event of conflict, the most stringent and recent requirements shall apply to the codes and standards above.

### **1.4 SYSTEM DESCRIPTION**

1. Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are to be bonded to telecommunications grounding and bonding system.
2. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labelled, and documented by the Contractor as detailed in this Section.
3. Product specifications, general design considerations and installation guidelines are provided in this Section.
4. The Contractor shall meet or exceed all requirements for the cable system described in this Section.



5. Local electrical codes shall be adhered to.
6. Local building codes shall be adhered to.
7. Motorola R56 standard shall be met in grounding of data center and 911 call taking/dispatching workstations.
8. All communications components including, entrance lugs, entrance terminal frames, racks, cabinets, cable tray, ladder racks, metallic pathways, enclosures, and other components noted on drawings shall be bonded to an independent grounding system and in accordance with local codes and standards, ANSI/TIA-607-D, and IEEE Std. 1100 and these specifications.
9. Grounding system shall include a local copper Secondary Bonding Busbar (SBB) (by Division 26) in Electrical Room bonded to a Telecommunications Bonding Backbone (by Division 26).
10. The SBB shall be bonded directly to the Primary Bonding Busbar (by Division 26).
11. The grounding system shall be visually verifiable and adequately sized to handle expected currents safely.
12. All grounding conductors and busbars shall be made of copper.
13. The grounding system shall be intentional, visually verifiable, adequately sized to handle expected currents safely, and direct these currents away from network equipment. As such, grounding shall be purposeful in its design and installation.
14. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and CSA certified and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.
15. Wherever possible, two-hole lugs shall be used. All lugs shall be irreversible compression and meet NEBS Level 3. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).
16. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
17. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.
18. Telecommunications grounding and bonding system consist of grounding busbars, bonding backbones, and other bonding conductors, as applicable to this project.
19. Provides ground reference for telecommunications systems within building.
20. Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are bonded to telecommunications grounding and bonding system.

## 1.5 SUBMITTALS

1. Shop Drawings:
  1. Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
2. Submit Operation and Maintenance (O&M) Data for all equipment in this Section in accordance with Section 01 78 23 – Operation and Maintenance Data. Include insulating liquid maintenance data.

## 1.6 ABBREVIATIONS

1. The following abbreviations are excerpted from the ANSI/TIA-607-D standard entitled: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises:
  1. PBB – Primary Bonding Busbar
  2. SBB – Secondary Bonding Busbar
  3. TBB – Telecommunications Bonding Backbone

4. RBB – Rack Bonding Busbar
5. TBC – Telecommunications Bonding Conductor
6. BBC – Backbone Bonding Conductor

## 1.7 QUALITY ASSURANCE AND CONTROL

1. Refer to Section 01 45 00 – Quality Control.
2. Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 – Health and Safety Requirements.

## 2 Products

### 2.1 PRIMARY BONDING BUSBAR (PBB)

1. The PBB shall be 6 mm (1/4") thick and 102 mm (4") wide and red stand-off 70 mm (2-3/4") from the backboard or wall.
2. The PBB shall be available in standard lengths of 305 mm (12") or 508 mm (20").
  1. Each 305 mm (12") PBB shall include a minimum of (12) 6 mm (1/4") with 16mm (5/8") spacing and (6) 10 mm (3/8") with 25 mm (1") spacing holes.
  2. Each 508 mm (20") PBB shall include a minimum of (24) 19 mm (3/4") with 16 mm (5/8") spacing and (6) 10 mm (3/8") with 25 mm (1") spacing holes.
3. Each PBB shall accept any lug with a 10 mm (3/8") bolt.

### 2.2 SECONDARY BONDING BUSBAR (SBB)

1. See electrical grounding busbar under Division 26 – Electrical.
2. The SBB shall be 6 mm (1/4") thick and 51 mm (2") wide and red stand-off 70 mm (2-3/4") from the backboard or wall.
3. The SBB shall be available in standard lengths of 254 mm (10"), 305 mm (12") or 508 mm (20").
  1. Each 254 mm (10") SBB shall include a minimum of (4) 6 mm (1/4") with 16 mm (5/8") spacing and (3) 10 mm (3/8") with 25 mm (1") spacing holes.
  2. Each 305 mm (12") SBB shall include a minimum of (6) 6 mm (1/4") with 16 mm (5/8") spacing and (3) 10 mm (3/8") with 25mm (1") spacing holes.
  3. Each 508 mm (20") SBB shall include a minimum of (12) 6 mm (1/4") with 16 mm (5/8") spacing and (3) 10 mm (3/8") with 25 mm (1") spacing holes.
4. Each SBB shall accept any lug with a 10mm (3/8") bolt.

### 2.3 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

1. Cable assemblies shall be UL Listed and CSA Certified and be a minimum of 6 AWG copper conductor, green insulated.
2. Telecommunications Grounding and Bonding Conductor Label Kits shall be supplied and installed by the Electrical Contractor at every rack and cabinet as well as one for every Secondary Bonding Busbar.
3. The bonding conductor size shall be as follows:

TBB Length in Linear Metres Metres (Feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0

## **2.4 TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)**

1. Cable assemblies shall be UL Listed and CSA Certified and be a minimum, the same size as the largest TBB copper conductor.
2. Shall be green insulated and marked in accordance with ANSI/TIA-607-D.

## **2.5 RACK BONDING BUSBAR (RBB)**

1. Vertical Rack-Mounted Busbar
  1. Vertical rack busbars provide a vertical ground continuity path between equipment along an equipment rack or cabinet face.
  2. Vertical rack busbars shall be constructed of electro-tin plated hard-drawn electrolytic tough pitch solid copper.
  3. Each vertical rack-mounted busbar shall be 16 mm (5/8") wide and 6 mm (1/4") thick.
  4. Vertical rack-mounted busbars shall bond a minimum of 45 standard EIA/ TIA rack units (RU) and shall include pairs of #1/4-20 tapped mounting holes on 16 mm (5/8") centers.
  5. Vertical rack-mounted busbars shall have standard lengths of 914 mm (36") and 1829 mm (72").
  6. Vertical rack-mounted busbars shall accept a minimum of one set of #5/16 self-clinching studs on 25mm (1") centers at both ends for attachment of a ground conductor.
2. Horizontal Rack-Mounted Busbar
  1. Horizontal rack busbars shall be constructed for installation on 483 mm (19"), 584 mm (23"), or 889 mm (35") standard equipment racks and cabinets that meet EIA-310-D.
  2. Horizontal rack busbars will be 5mm (3/16") thick and 19 mm (3/4") wide.
  3. Horizontal rack busbars shall include a minimum of eight #6-32 tapped lug mounting holes on 25 mm (1") centers and two pairs of 8 mm (5/16") diameter holes spaced 16mm (5/8") apart for attaching ground jumpers.

## **2.6 MATERIALS**

1. Cable Runway Ground Strap
  1. General:
    1. Cable runway ground straps provide a ground pathway between cable pathway segments/ runway lengths when fastened together across pathway/ runway splices.
    2. Cable runway ground straps shall be constructed of UL Listed components.
  2. Size:
    1. Each cable runway ground strap shall consist of a minimum 8-inch long #6 AWG green/ yellow insulated stranded copper conductor attached at both ends to two-hole compression lugs.
    2. Each compression lug at each end of the conductor shall include two 6 mm (1/4") bolt holes spaced on 16 mm (5/8") centers.
2. Ground Jumper
  1. Ground Jumpers provide common grounding from the equipment, equipment rack or cabinet to the halo conductor, grounding strip or grounding busbar.
  2. Ground Jumpers shall be constructed of minimum #6 AWG green/ yellow insulated stranded copper conductor attached to a compression lug at each end.
  3. Each compression lug at each end of the conductor shall include two 6mm (1/4") bolt holes spaced on 16 mm (5/8") centers. Compression lugs shall be available with 90° and 45° angles.
  4. Ground jumper shall be available in 610 mm (2-foot), 914 mm (3-foot), and 2743 mm (9-foot) lengths.
  5. Constructed of UL Listed components.

3. Two Mounting Hole Ground Terminal Block:
  1. Terminal blocks shall provide a method for attaching ground wires to racks or cabinets.
  2. Terminal blocks shall be constructed of extruded, high-strength aluminum.
  3. Terminal blocks shall accept conductors from #14 AWG through 2/0 AWG.
  4. Each terminal block shall include two #3/8-24 x 22 mm (7/8") stainless steel hex head set screws.
  5. Terminal blocks shall be UL Listed and meet BICSI and ANSI/EIA/TIA two-hole mounting recommendations.
4. Code/Flex Conductor Tap
  1. Code/ Flex conductor taps shall be provided a method for tapping into continuous conductors as a splice or pigtail.
  2. Each tap shall support #6 - #10 AWG, #2 - #6 AWG, 250 kcmil - #2 AWG, and 4/0 - #2 AWG run and #2 - #6 AWG, #2 - #8 AWG, and #8 - #14 AWG taps.
  3. Each tap groove shall be constructed separately from one another to allow each groove to function independently of one another.
  4. Taps shall be UL Listed and CSA Certified with AWG conductors for applications up to 600V.
  5. Clear high impact plastic covers shall be provided with each tap and shall meet the following requirements:
    1. Each cover shall allow complete 360° inspection of the crimp connection to assure that the crimp was made properly.
    2. Each cover shall allow labels to be added to and protected by either side of the cover.
    3. Each cover shall include molded flash barriers encompassing the tap and crimp to provide protection against electrical flash over.
    4. The high impact plastic shall meet the UL 94V-0 flame rating and oxygen index of 28 providing self-extinguishing, flame-retardant properties.
    5. Each cover shall include the part number, voltage rating, and temperature rating molded into the cover.
5. U-bolt Style Grounding Clamp
  1. U-bolt style grounding clamps shall provide a method to ground copper conductors to rods, tubes, or pipes at parallel or right angle.
  2. Clamps shall be constructed from high strength, electrolytic cast bronze.
  3. Clamps hardware shall be constructed from high strength silicon bronze hardware.
  4. Clamps shall be UL Listed for grounding and bonding with AWG conductors and suitable for direct burial in earth or concrete.
  5. U-bolt clamps shall accept the following pipe sizes: 13 mm (1/2"), 19 mm (3/4"), 25 mm (1") and the following ground rod sizes: 22 mm (7/8") and 25 mm (1").
  6. U-bolt clamps shall accept the following conductor sizes: #8 SOL - #4 STD AWG and #4 SOL - 3/0 STD AWG.

## 2.7 WARNING LABELS

1. Non-metallic warning labels in English and French to ANSI/TIA-607-D.

## 3 Execution

### 3.1 GENERAL

1. The grounding and bonding system shall provide equipment ground connections (bonds) from the premises entrance facility and outside-plant grounding system to each telecommunication room telecommunication ground busbar, through the racking systems to bond the network equipment.
2. The entire grounding link from equipment to earth should be visually verifiable except where hidden by walls, conduit, or pathways.

3. The Contractor shall ensure that all elements of the communications bonding network are labelled according to guidelines defined in ANSI/TIA-607-D and ANSI/TIA 606-D.

### **3.2 TELECOMMUNICATIONS BONDING BACKBONE (TBB)**

1. Bonding and grounding conductors may be insulated or un-insulated and shall not decrease in size as the grounding path moves closer to earth.
2. Connections (bonds) between the telecommunications grounding network and associated electrical panels shall be done by a qualified electrician in accordance with guidelines in ANSI/ANSI/TIA 607-D and applicable electrical codes.
3. Bonding Conductors should be continuous and routed in the shortest possible straight-line path, avoiding changes in elevation and sharp bends.
4. TBB conductors shall be protected from mechanical damage and built so as to minimize splicing. Where splicing is unavoidable, they shall be done using irreversible compression splices (C-TAPS) built to that purpose. See the "Materials" section of this document for appropriate compression splices.
5. Routing grounding conductors through ferrous metal conduit should be avoided, but if it is necessary due to building constraints, any grounding conductor running through ferrous conduit longer than 3 feet shall be bonded at the end using appropriately sized HTAP and Conduit grounding clamps as described ANSI/TIA 607-D-Busing appliances described for that purpose in the "Materials" section of this document.
6. Conductors used to bond TBB to conduit ends shall be of #6 AWG size or larger.

### **3.3 CUTTING, PATCHING AND REPAIRING**

1. Racks and Cabinets shall be bonded into the communications bonding network with conductors of #6 AWG or larger.
2. Racks and cabinets shall have individual Rack Bonding Conductors (RBC) bonding to the Rack Bonding Busbar (RBB) or underfloor Supplemental Bonding Grid.
3. In smaller Telecommunications Rooms (3-5 racks) it is acceptable to have Rack Bonding Busbar (RBB) that go directly from each individual rack to the SBB.
4. Rack Bonding Conductors (RBC) or Rack Bonding Busbar (RBB) shall be installed to maintain a minimum of 51 mm (2") separation from all other types of cable - power or communications.
5. Depending on size of the telecommunications room, Rack Bonding Conductors (RBC) may tap into underfloor or overhead grounding conductors, or for smaller TRs (3-5 racks or cabinets), may go directly from the rack to the wall mounted busbar.
6. Racks, cabinets, and similar enclosures shall not be attached serially (daisy-chained) but must have individual RBC into the grounding system.
7. Newly installed racks and cabinets shall have vertical grounding busbars installed along one rail to provide clean bonding landing point for all rack mount equipment. Grounding busbars shall not be isolated from the rack or cabinet.
8. All painted components of racks/cabinets shall be assembled using serrated grounding washers and thread-forming screws to ensure electrical continuity between the different structural components of the rack/cabinet.
9. Larger equipment (chassis switches) with integral grounding terminals or pads shall be bonded to the vertical busbar with equipment grounding kits attached to those terminals and bonding them to the rack-mounted busbars.
10. Anywhere two metallic surfaces are to be bonded, contractor shall clean the contact areas of paint or oxidation using abrasive pads and apply film of anti-oxidation compound between surfaces prior to bonding.

11. All cable fittings shall be of two-hole (LCC series) compression-type. Mechanical screw-lugs on racking systems will not be accepted and must be removed and replaced at contractor's expense.
12. All screws used to affix compression lugs to rack-mounted vertical busbars shall be of the thread forming type made specifically for electrical bonding.
13. Smaller equipment (servers, TOR switches) not having integral grounding pads must be bonded to the rack through the equipment mounting flanges using green thread-forming grounding screws with serrations under the head to cut through paint, coatings and oxidation that may be present on the equipment flange. Such equipment shall have minimally one grounding screw per piece of equipment.
14. ESD (electro-static discharge) ports and wrist straps shall be provided minimally every other rack or bay to be within reach of any active equipment. On larger 4-post racks or cabinets - ESD ports and wrist straps shall be installed on the front and back to be accessible when servicing any active equipment.
15. All Contractor personnel servicing active equipment must be wearing a properly grounded wrist strap to dissipate ESD charges prior to touching any active equipment.

### **3.4 INSTALLATION AND INSPECTION - GENERAL**

1. The equipment/products shall be installed as indicated on the Contract Drawings and these specifications, in accordance with the Manufacturer's recommendations and as approved by the Engineer.
2. Provide the services of a factory trained representative(s) to inspect, operate, test, adjust, and troubleshoot the installations.
3. Inspection to include checking for:
  1. Cracks and other damaged or defective parts. Each equipment/product, as well as accessories, must be undamaged, without cracks and free of defective parts.
  2. Completeness of installation as specified and as recommended by the Manufacturer.
  3. Correctness of setting, alignment, and relative arrangement of various parts of the system.
4. Provide for additional supervision of installation by Equipment Manufacturer as required. Arrange with the Engineer a mutually agreeable date when the representative should be on site.
5. Complete on-site testing (and off-site testing where specified), and provide the results of the tests, all in accordance with Section 01 45 00 – Quality Control.
6. Submit a report, signed by the Manufacturer's representative, describing in detail the inspection, tests, and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance. The report must verify that the equipment/products conform to all specifications.

### **3.5 SUPERVISION OF INSTALLATION AND COMMISSIONING - GENERAL**

1. Provide commissioning and startup in accordance with these specifications.
2. At the completion of satisfactory installation, each unit shall be started by the Contractor under the supervision of the Manufacturer and in conjunction with plant operating conditions.
3. Equipment/products shall only be accepted after receipt of a satisfactory report submitted by the Manufacturer's representatives.
4. Modify or replace equipment/products failing required tests.
5. Perform additional testing required due to changes of equipment/products and/or failure of equipment/products or construction to meet specifications at no extra cost to the Owner.

### **3.6 PERFORMANCE TESTS - GENERAL**

1. Complete on-site testing (and off-site testing where specified) and provide the results of the tests, all in accordance with Section 01 45 00 – Quality Control and these specifications.
2. The field service representative(s) shall submit to the Engineer a written report stating that the equipment/products have been checked and is suitable for operation.

### **3.7 STORAGE**

1. Prior to installation, the equipment/products and accessories shall be protected and stored indoors in a dry area, in accordance with the Manufacturer's recommendations.

### **3.8 OPERATION AND MAINTENANCE (O&M) DATA**

1. Submit Operation and Maintenance (O&M) Data for all equipment/products in this Section in accordance with Section 01 78 23 – Operation and Maintenance Data.

### **3.9 TRAINING**

1. Unless otherwise specified, provide Demonstration and Training in accordance with Section 01 78 23 – Operation and Maintenance Data.

### **3.10 BONDING GENERAL**

1. When placed in ferrous metallic conduit or EMT longer than 1 m, bond to each end of conduit or EMT using 6AWG copper conductor.
2. Outdoor grounding and bonding connections.
  1. All outdoor grounding and bonding (earthing) connections shall be accomplished using exothermic welding.
3. Rack-Mount Busbars and Ground Bars
  1. Add a rack-mount horizontal or vertical busbar or ground bar to the cabinet. The rack-mount busbar or ground bar provides multiple bonding points on the cabinet for cabinet and rack-mount equipment.
  2. Attach rack-mount busbars and ground bars to racks or cabinets according to the manufacturer's installation instructions.
  3. Bond the rack-mount busbar or ground bar to the room's main grounding busbar with appropriately sized hardware and conductor.
  4. Minimum bonding connection to cabinets shall be made with a rackmount two-hole ground terminal block sized to fit the conductor and cabinet and installed according to manufacturer recommendations.
  5. Remove paint between cabinet and terminal block, clean surface and use antioxidant between the cabinet and the terminal block to help prevent corrosion at the bond.
4. Bonding Conductor for Telecommunications
  1. Install bonding conductor for telecommunications from communications rack to service equipment (power) ground.
  2. Use exothermic welding, 2-hole non-twisting lugs for connection to electrical grounding busbar.

### **3.11 LABELLING**

1. Apply warning labels to telecommunications bonding and grounding conductors.
2. Apply additional administrative labels to: TIA/EIA-606-D.

**END OF SECTION**

## **1 General**

### **1.1 INTRODUCTION**

1. Information and Communication Technology (ICT) systems require specific pathway and design construction practices. This section specifies the pathway infrastructure to be installed, based on the ANSI/TIA-569-D standard: "Commercial Building Standard for Telecommunications Pathways and Spaces."
2. An empty telecommunications pathway system consists of outlet boxes, cover plates, wire basket trays, conduits, pull boxes, junction boxes, sleeves and caps, fish wires, service poles, service fittings, concrete encased ducts, modular poke-throughs.
3. A wire basket tray system will be utilized in data closets and data center for cable distribution.
4. A conduit system shall be installed for backbone cabling, behind wall cabling, open ceiling, dry wall ceiling and exterior in accordance with these Division 26 Electrical Specifications.
5. A J-hook system shall be installed for interior areas above suspension ceiling for horizontal cables branching out to work outlet device locations.
6. Conduits shall be rated per area by building classification.
7. If there are any questions, please contact the Owner Representative for clarification.

### **1.2 RELATED REQUIREMENTS**

1. Division 26 – Electrical:
  1. Section 26 05 00 – General Electrical Requirements
  2. Section 26 05 05 – Basic Materials and Methods

### **1.3 REFERENCE STANDARDS**

1. Canadian Standards Association (CSA Group):
  1. CAN/CSA C22.1 No.126.1-02, Metal Cable Tray Systems.
  2. CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  3. CSA C22.2 No. 45, Rigid Metal Conduit.
  4. CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  5. CSA C22.2 No. 83, Electrical Metallic Tubing.
  6. CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.
  7. CAN/CSA C22.2 No. 227.3-05, Non-metallic Mechanical Protection Tubing (NMPT), A National Standard of Canada
2. National Electrical Manufacturers Association (NEMA):
  1. NEMA FG 1, Fibreglass and Cable Tray Systems.
  2. NEMA VE 1, Metal Cable Tray Systems.
  3. NEMA VE 2, Cable Tray Installation Guidelines.
3. TIA/EIA, Latest version:
  1. TIA/EIA-568 D Series Commercial Building Telecommunications Cabling Standard.
  2. TIA/EIA-569 Commercial Building Standard for Telecommunications Pathway and Spaces.
  3. TIA/EIA-606 Administration Standard for Commercial Telecommunications Infrastructure.
  4. TIA/EIA-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
  5. TIA/EIA-758 Customer Owned Outside Plant Telecommunications Cabling Standard.
  6. TIA/TSB-184 Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling



4. BICSI, Latest version:
  1. BICSI – Outside Plant Design Reference Manual.
  2. BICSI – Telecommunication Distribution Methods Manual.
  3. BICSI – Information Transport System Installation.
  4. BICSI – Network Design Reference Manual.
  5. ANSI/BICSI 005-2016 Electronic Safety and Security (ESS) System Design and Implementation Best Practices
5. Local Codes and Standards – all applicable
6. Local Authority Having Jurisdiction (AHJ)
7. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.
8. If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Owner representative in writing.
9. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
10. In the event of conflict, the most stringent and recent requirements shall apply to the codes and standards above.

#### **1.4 INDOOR CABLE DISTRIBUTION**

1. Ensure ANSI/TIA-568-D installation practices are followed for all indoor cable distribution.
2. The Contractor shall install and distribute cabling using sleeves, conduit, communications cable tray as indicated on drawings and as supplied and installed by Division 26 – Electrical.

#### **1.5 SUBMITTALS**

1. Shop Drawings:
  1. Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures and Section 26 05 00 – General Electrical Requirements.
2. Submit Operation and Maintenance (O&M) Data for all equipment in this Section in accordance with Section 01 78 23 – Operation and Maintenance Data. Include insulating liquid maintenance data.

#### **1.6 QUALITY CONTROL**

1. Refer to Section 01 45 00 – Quality Control.

### **2 Products**

#### **2.1 CONDUIT**

1. Refer to Section 26 05 21 – Wires and Cables (0-1000V).
2. The minimum trade size is 25 mm (1").

#### **2.2 J-HOOK**

1. Provide J-Hook system components that are plenum-rated (regardless of whether air plenum ceilings exist on the project). Provide J-Hooks, not Cable Fasteners, and not Bridle Rings. Provide open-top hooks, so cables can be laid into the J-Hooks rather than threaded through. Provide tool-less cable retainer clips (do not use cable ties). Provide hooks sized for maximum 40% fill (in cross section) based on outside diameter of cables. Accordingly, provide multiple sets of J- Hooks along any given pathway as applicable.

2. Provide steel units with rolled hook edges to prevent damage to cable jackets and insulation.
3. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.
4. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.
5. Provide necessary factory hooks, cable retainers, fasteners, attachment kits, etc. as required for complete installations.
6. Typical J-hook size and cable capacity:

	CAT5e	CAT6	CAT6A
27 mm (1") (Size 16)	20	15	10
35 mm (1 5/16") (Size 21)	50	40	25
53 mm (2") (Size 32)	90	60	35
78 mm (3") (Size 48)	200	150	80
103 mm (4") (Size 64)	330	220	140

7. Approved Manufacturer:
  1. Chatsworth Products, Inc.
  2. Cooper B-Line
  3. ERICO
  4. Snake Tray by Cable Management Solutions, Inc.
  5. Approved equal.

### 2.3 CABLE TRAYS

1. Refer to Section 26 05 36 – Cable Trays for Electrical Systems.
2. Type: Wire mesh basket cable tray.
3. The cable tray in the Data Closets will be 410 mm (16") (Width) x 100 mm (4") (Height).
4. The cable tray in the Data Center will be 610 mm (24") (width) x 100 mm (4") (Height).
5. Approved Manufacturer:
  1. WBT.
  2. CER.
  3. Flex Tray.
  4. Approved equal.

### 2.4 CONDUIT FITTINGS

1. Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 50 mm (2") and double screw indenter fittings for conduits 50 mm (2") and larger.
2. Die-cast or pressure cast fittings are not permitted.
3. Connectors shall have insulated throat up to and including 25 mm (1") size. For sizes 35 mm (1-1/4") and larger, provide plastic insulating bushing.
4. Provide conduit body types, shapes and sizes as required to suit application, CEC, and Category 6A cable blend radius requirements. Provide matching gasket covers secured with corrosion-resistant screws.

### 2.5 EXPANSION FITTINGS

1. Provide expansion fittings with external grounding straps at building expansion joints.
2. Minimum 100 mm (4") movement in either direction.
3. At expansion joints in concrete pours, provide deflection/expansion fittings capable of movement of 19 mm (3/4") in all directions from the normal.

## **2.6 WATER PROOFING SEALS**

1. Provide watertight expanding link-type seals for installation between the conduit and the sleeve or core drilled hole.

## **2.7 JUNCTION BOX**

1. For standard non chemically hazardous environments junction boxes shall be constructed of not less than 14-gauge pre-galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. All junction boxes in public spaces; they have to be lockable.
2. Provide screw-on type cover boxes installed in damp or wet locations shall be of rain-tight construction with gasketed cover and threaded conduit hubs.
3. Boxes shall be NEMA approved for the environmental condition of the location where they will be installed.
4. Junction box size shall maintain Category 6A UTP cable bend radius requirement.

## **2.8 PULL CORD**

1. All new conduits shall be equipped with a pull cord that has a minimum test rating of approximately 90 kg (200 lb).

## **2.9 FIRE RATED PATHWAY (FIRE-STOPPING)**

1. A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapour, and pressurized water stream.
2. Fire-stop systems in commercial premises shall meet the requirements of ANSI/TIA-569-E.
3. Fire stop systems should be designed to be compatible with the worst-case environment to which they will be exposed (refer to ANSI/TIA-568.0-D for information on environmental classifications).
4. All data, video, and communications cable bundles shall utilize an enclosed fire-rated pathway device wherever said cables penetrate rated walls.
5. The fire rated pathway shall contain a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated.
6. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials.
7. To be installed in fire rated walls where cable tray must penetrate fire rated walls.
8. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure).
9. Provide fire stop system where cable /cable tray penetrates fire rated walls, floors, partitions, and ceilings to ensure that the fire rating is maintained. For conduit penetration, Putty or other type firestop shall be used. Abandoned penetrations shall be properly fire stopped.
10. The required fire rating is minimum 2 hours.
11. Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer, licensed (actual or reciprocal) in the province where the work is to be performed. A drawing showing the proposed fire-stop system, stamped/embossed by the Professional Engineer, shall be provided to the Owner Representative prior to installing the fire-stop system(s).

12. Firestop system size based on cable quantities plus future additional 20% cable expansion needs.

### 3 Execution

#### 3.1 GENERAL

1. Pathways shall meet the requirements of current ANSI/TIA-569.
2. Pathways should be compatible with the worst-case environment to which they will be exposed (see current ANSI/TIA-568 for information on environmental classifications).
3. Pathways shall comply with local codes and regulations.
4. Cable tray shall be used above ceilings in commercial facilities.
5. All pathway (conduit and cable tray) systems shall be installed in accordance with the latest version of the ANSI/TIA 569 Standard which exceeds the minimum requirements of Canadian Electrical Code. Pathway systems that are designed only to the Canadian Electrical Code and do not include all requirements of the current ANSI/TIA 569 standard will be considered substandard and removed until such time as they are in compliance.
6. Contractor to confirm with Owner's Representative regarding the areas that are suitable for conduit.
7. Contractor to confirm with Owner's Representative regarding the areas that are suitable for cable tray, if suitable, what material type given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.
8. Cable tray and conduit shall be labeled every 15 meters (50 ft.) on the outer surface as "LAN BACKBONE" or "LAN HORIZONTAL".
9. There shall be small labels identifying the source and destination of cables in case there are multiple cables carried by the cable tray and conduit.

#### 3.2 INSTALLATION AND INSPECTION – GENERAL

1. The equipment/products shall be installed as indicated on the Contract Drawings and these specifications, in accordance with the Manufacturer's recommendations and as approved by the Engineer.
2. Provide the services of a factory trained representative(s) to inspect, operate, test, adjust, and troubleshoot the installations.
3. Inspection to include checking for:
  1. Cracks and other damaged or defective parts. Each equipment/product, as well as accessories, must be undamaged, without cracks and free of defective parts.
  2. Completeness of installation as specified and as recommended by the Manufacturer.
  3. Correctness of setting, alignment, and relative arrangement of various parts of the system.
4. Provide for additional supervision of installation by Equipment Manufacturer as required. Arrange with the Engineer a mutually agreeable date when the representative should be on site.
5. Complete on-site testing (and off-site testing where specified) and provide the results of the tests.
6. Submit a report, signed by the Manufacturer's representative, describing in detail the inspection, tests, and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance. The report must verify that the equipment/products conform to all specifications.

### **3.3 SUPERVISION OF INSTALLATION AND COMMISSIONING - GENERAL**

1. Provide commissioning and startup in accordance with these specifications.
2. At the completion of satisfactory installation, each unit shall be started by the Contractor under the supervision of the Manufacturer and in conjunction with plant operating conditions.
3. Equipment/products shall only be accepted after receipt of a satisfactory report submitted by the Manufacturer's representatives.
4. Modify or replace equipment/products failing required tests.
5. Perform additional testing required due to changes of equipment/products and/or failure of equipment/products or construction to meet specifications at no extra cost to the Owner.

### **3.4 PERFORMANCE TESTS – GENERAL**

1. Complete on-site testing (and off-site testing where specified) and provide the results of the tests.
2. The field service representative(s) shall submit to the Engineer a written report stating that the equipment/products have been checked and is suitable for operation.

### **3.5 J-HOOK INSTALLATION**

1. Provide J-Hook support along “free-air” cable pathway routes. Provide J-Hooks at maximum 1.5m intervals and at offsets. Route J-Hooks above ceilings through corridors and similar open areas wherever possible to minimize above-ceiling wall penetrations.
2. Layout and install all electrical work in strict compliance with Chapter 1, Part B, Section 110.26 of the latest adopted edition of NFPA 70. Locations and routing that may be shown on plans are schematic and diagrammatic in nature. Layout all proposed pathway routing, elevations, installation methods, etc. on coordination drawings and coordinate all proposed routing with all affected trades prior to commencing with work. In addition, review the information with Owner and Design Professionals for all areas where pathways will be visible after completion of construction, to ensure a neatly organized installation occurs. Where exposed in finished areas, install in a manner that minimizes detrimental effects on room aesthetics. Install as out of site as reasonably possible.
3. Keep pathways at least 24 inches away from parallel runs of flues and steam or hot- water pipes. Install horizontal runs above liquid and steam piping. Level and square runs and install at proper elevations and heights. Do not begin installation of cables until J-Hook pathway installations are complete and until installation locations (end to end) are in a weatherproof environment. Install pathways so that they are accessible for cable installation after construction is complete. Install pathways with enough workspace to permit access for installing cables. Strictly adhere to factory load capacities and fill capacity. Provide factory cable retainers, fasteners, attachment kits, and other accessories as required for a complete installation.
4. Securely anchor (mechanical, not adhesive) J-Hooks directly to structural components of the building. Do not anchor J-Hooks to ductwork, conduit, piping, fixtures, equipment, ceiling supports (rods, wires, T-bars), etc. Comply with requirements in Division 26 – Electrical and related sections for hangers and supports. Support using factory- approved methods. Fasten cables on horizontal runs with factory cable clamps, retainers, fasteners, attachment kits or flexible Velcro-secured wraps compliant with to NEMA VE 2. Tighten clamps/wraps only enough to secure the cable, without indenting the cable jacket. Use of synthetic or plastic “tie-wraps”, “zip ties”, “wire ties” and similar products are not permitted as a permanent means of anchoring, securing, supporting, or otherwise installing any cables, conductors, conduits, raceways, devices, equipment, or other electrical work. Do not use perforated strap.

5. Coordinate work prior to rough-in with respective equipment and cable installers, and with Owner's Representative. Carefully coordinate proposed routing, including elevations, with affected installers and entities prior to rough-in. Neatly route paths parallel and perpendicular to building architectural lines, plumb on walls, and at a consistent elevation wherever possible. Install paths in a uniform plane/elevation wherever possible. Keep horizontal and vertical offsets to an absolute minimum. Route paths so that a minimum of 24 inches exists between cables and potential EMI sources such as lighting ballasts, motors, power wiring, dimmer circuits, etc.
6. Provide a minimum of two (2) 100 mm (4") bushed conduit sleeves where pathway is routed above inaccessible ceilings, and at penetrations of floors, masonry walls, fire rated walls, smoke-tight partitions, smoke-rated partitions, and similar elements. Provide smoke and fire stopping at such penetrations as applicable in Division 26 – Electrical. Provide EMT conduit for "drops" from paths to outlets and equipment, with sweep bends, insulated throat fittings and 200-pound pull string.

### 3.6 CABLE TRAY INSTALLATION

1. All cable trays shall be wire-mesh/basket-tray type, prefabricated structure 300 mm (12") in width or greater, unless otherwise noted. Refer to drawings for cable tray sizes.
2. Should aluminum trays be specified (Owner approval is mandatory), the Engineer is to ensure that, during the grounding or bonding aspects of the installation, the Contractor uses tin plated or zinc coated ground connectors.
3. All metal cable trays shall be bonded together to the PBB or an SBB.
4. All metal cable trays shall be coated to prevent rust or galvanic action. Only pre-galvanized cable trays shall be acceptable. Post galvanized hot dipped trays and components are not acceptable.
5. Accessories and fittings such as elbows and reducers shall be manufactured by the cable tray manufacturer.
6. Install cable trays at least 300mm away from fluorescent luminaries and cross power cables at right angles.
7. The minimum clearances for cable trays shall be in accordance with Canadian Electrical Code C22.1-09.
8. Allow 150 mm (6") vertical clearance excluding the depth of cable trays, between cable trays installed in tiers except where cables of 50 mm (2") diameter or greater are installed then the clearance shall be 305 mm (12"), and Minimum 200 mm (8") vertical clearance from the top of cable trays to all ceilings, 305 mm (12") clearance from heating ducts and heating equipment and 150mm for short length obstructions.
9. A minimum of 75mm clear vertical space shall be available above the ceiling tiles for the cabling and pathway.
10. 600mm horizontal clearance on one side of cable tray mounted adjacent to one another or to walls or other obstructions.
11. All cable trays shall be labeled at regular intervals. The distance separating labels shall not exceed 15 meters.
12. The maximum cable tray fill ratio is 50% (on field)
13. Cable tray is to be used for all communication cables not run-in conduit/raceway. Provide partitioning to separate individual system cables.
14. Waterfall tray shall be installed above Network/Server rooms to meet the bend radius requirements of cable installation.

### 3.7 CONDUIT INSTALLATION

1. Conduit shall be installed as indicated in the drawings. Only Velcro ties are allowed. Plastic cable ties are not allowed in any condition.
2. The inside radius of a bend in a conduit shall be not less than six times the internal diameter when the conduit is less than 50 mm (2") in diameter and ten times the internal diameter when conduit is 50 mm (2") in diameter or larger.
3. All zone conduits shall be identified and labeled at both ends, any transition section and at regular intervals not to exceed 10 meters. Tags shall identify start and finish of conduit runs. Pull boxes shall be labeled on the exposed exterior.
4. All conduits shall originate and be physically connected to the telecom backboards in the Equipment Room, Telecommunications Room, cable tray and pull box.
5. All metallic parts of the cable distribution supporting system shall be bonded together mechanically inclusive of all transition points (i.e., cable tray and distribution conduit not mechanically connected) using a 6 AWG green jacketed stranded copper ground wire. The metallic components of the cable distribution system shall be bonded together at the communications/server rooms, and then bonded to their respective telecom ground busbars.
6. All fittings, connectors and couplings shall be of the same material as the conduit used on site.
7. All conduits/sleeves that enter the communications/server rooms shall be fitted with an approved ground bushing with ground lug and bonded together mechanically (one continuous piece preferred). This shall be connected to the approved building ground by means of a No. 6 AWG to the grounding bus bar.
8. Cable fill capacities of conduit shall not be greater than 40%, plus 25% spare for future installation.
9. All conduits entering or existing through the ceiling or walls of the communications/server rooms shall protrude into the room 25 – 50 mm (1/2" – 1").
10. Riser sleeves in the communications/server rooms shall protrude through the floor 50-75mm above finished floor (AFF).
11. All conduit runs shall follow building grid lines and shall be concealed where possible.
12. All conduits shall be the types as per the application, reamed and bushed at both ends and bonded to the distribution system.
13. All conduit runs shall not exceed a maximum of 30 meters (100 ft.) in length with a maximum of two 90-degree bends between pull points without a pull box, unless otherwise specified.
14. Conduits ending in the vicinity of a cable tray shall be terminated at a height of no less than 100mm and no more than 150mm from the top of the cable tray. Conduit runs shall not be punched through the side of the cable tray. Conduit ends are to be bonded to the cable tray.
15. The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
16. Conduit fittings shall not be used in place of pull boxes or bends.

### 3.8 PULL BOX INSTALLATION

1. A pull box shall be placed in conduit runs where the sum of the bends exceeds 180 degrees, where the overall length of the conduit run is more than 30 m (98'), or if there is a reverse bend in the run.
2. Pull boxes shall be constructed and sized in accordance with Canadian Electrical Code, TIA and BICSI standards of code gauge steel and shall have a rust resistant finish.

3. In all instances pull boxes shall be placed in straight sections of conduit run and shall not be used in lieu of a bend. Corresponding ends of the conduit are to be aligned with each other. Conduit fittings shall not be used in place of pull boxes or bends.
4. Pull boxes shall be installed at a reasonable height, in an exposed location and such that access for installation of cables is not prohibited. Pull boxes shall not be placed in a fixed false ceiling space, unless immediately above a suitably marked and hinged access panel. Provide indicator decals on ceiling T-bar rail or ceiling tiles showing location of pull box or splice box.
5. Conduit must enter the outlet boxes from the top or bottom.
6. All conduits shall be installed in accordance with Canadian Electrical Code, Part 1 Section 12, applicable building codes and current TIA/EIA 569.
7. The minimum trade size for conduit running between the Equipment Room or a Telecommunications Room and the Telecommunications outlet at an outlet location is twenty-seven millimeters (27mm).
8. The maximum horizontal cable run distance shall not exceed 90 meters.
9. The cable length from the mechanical termination in the TR and ER to the Telecommunications outlet, where the horizontal distance exceeds 90 meters, provided additional rooms as required.
10. Future requirements for additional cables to each outlet shall be considered.
11. A pull cord shall be installed in all conduits and the pull cord shall be left inside of conduit (for future expansion) after cables installed.
12. Place pull boxes in readily accessible locations only.
13. The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
14. There shall be no attachment of pull boxes or any type of panel/enclosure onto the surface of the Telecom Enclosure / Cabinet / Rack. It is strictly prohibited and shall not be allowed in any circumstances to have a box or enclosure attached/fixed on the surface of a Telecom Enclosure / Cabinet / Rack.

### 3.9 INDOOR CABLE DISTRIBUTION

1. All pathways and cabling installation shall maintain clearances from all electrical and heat sources as outlined below.

Fluorescent Fixtures	30 cm
Electrical distribution cabling and conduits less than 1KVA	1.0 m
Electrical distribution cabling and conduits greater than 1KVA	3.0 m
Transformers and Motors	1.2 m
HVAC system including ducts	30 cm
Mechanical piping	15 cm

2. Prepare all conduits and pathways prior to installation of cabling. This shall include bushing or reaming all conduit openings, pulling of wire brush and mandrel to clean out ducts and identifying any potential cause of damage to cabling during installation. Report all items to the Engineer immediately.

### 3.10 OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1. Support boxes Independently of connecting conduits.
2. Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
3. For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.



4. Provide correct size of openings in boxes for conduit, mineral insulated and armored cable connections. Do not install reducing washers.
5. Vacuum clean interior of outlet boxes before installation of wiring devices.
6. Identify systems for outlet boxes as required.
7. For all public areas, elevator lobbies, corridor, and stair/landing areas. All conduits and/or cable trays are crossing those areas are to be rigid conduits and enclosed trays with secured covers. Also, for more conduit details, refer to Division 26 – Electrical.

### **3.11 CLEANING**

1. Proceed in accordance with Section 01 74 23 – Final Cleaning.
2. On completion and verification or performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.

### **3.12 EXAMINATION**

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

### **3.13 INSTALLATION**

1. Install empty raceway system, including ceiling distribution system, fish wire, cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, concrete encased ducts, miscellaneous and positioning material to constitute complete system.

### **3.14 PROTECTION**

1. Protect installed products and components from damage during construction.
2. Repair damage to adjacent materials caused by pathways for communications systems installation.

### **3.15 STORAGE**

1. Prior to installation, the equipment/products and accessories shall be protected and stored indoors in a dry area, in accordance with the Manufacturer's recommendations.

### **3.16 OPERATION AND MAINTENANCE (O&M) DATA**

1. Submit Operation and Maintenance (O&M) Data for all equipment/products in this Section in accordance with Section 01 78 23 – Operation and Maintenance Data.

### **3.17 TRAINING**

1. Unless otherwise specified, provide Demonstration and Training in accordance with Section 01 78 23 – Operation and Maintenance Data.

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Division 26 – Electrical

### **1.2 REFERENCE STANDARDS**

1. Canadian Standards Association (CSA Group):
  1. CSA-C22.2 No. 214-02, Communications Cables (Bi-National standard with UL 444).
  2. CSA-C22.2 No. 232, Optical Fiber Cables.
2. Telecommunications Industry Association (TIA) / Electronic Industries Alliance (EIA):
  1. TIA/EIA-568 D Series Commercial Building Telecommunications Cabling Standard.
  2. TIA/EIA-569 Commercial Building Standard for Telecommunications Pathway and Spaces.
  3. TIA/EIA-606 Administration Standard for Commercial Telecommunications Infrastructure.
  4. TIA/EIA-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
  5. TIA/EIA-758 Customer Owned Outside Plant Telecommunications Cabling Standard.
  6. TIA/TSB-184 Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
3. Building Industry Consulting Services Industry (BICSI):
  1. BICSI - Outside Plant Design Reference Manual.
  2. BICSI – Telecommunication Distribution Methods Manual.
  3. BICSI – Information Transport System Installation.
  4. BICSI – Network Design Reference Manual.
  5. ANSI/BICSI 005 Electronic Safety and Security (ESS) System Design and Implementation Best Practices

### **1.3 DEFINITIONS**

1. Terminology: Refer to TIA/EIA-598, Annex A for definitions of terms: optical-fiber interconnect, distribution, and breakout cables.

### **1.4 SYSTEM DESCRIPTION**

1. Structured telecommunications wiring system consist of unshielded-twisted-pair and optical fiber cables, terminations, connectors, cross-connection hardware, and related equipment installed inside building for occupant's telecommunications and security systems, including voice, data, CCTV, and access control.
2. Installed in physical star configuration with separate horizontal and backbone sub-systems.
  1. Horizontal cables link work areas (CCTV locations, CAT6A drops, etc.) to telecommunications cabinet/space.
  2. Telecommunications spaces linked to main terminal/equipment room (MT/ER) in main operations building by backbone cables.

### **1.5 ACTION AND INFORMATIONAL SUBMITTALS**

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. The submission shall include, but not be limited to, the following:
  1. Confirmation of the understanding of the milestones, timelines, and sequence of construction within Section 01 32 00 – Schedules.
  2. Other submittals as listed in this specification and for all equipment/products.
  3. Provide Microsoft Access database reflecting cable installation and cross-connections.
  4. Provide electronic drawings in AutoCAD format depicting all construction.

5. Provide electronic copies of record drawings to Owner Representative.
6. Provide and place one hard copy of record drawings for each telecommunications space.

#### **1.6 SUBMITTALS**

1. Shop Drawings:
  1. Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
2. Submit Operation and Maintenance (O&M) Data for all equipment in this Section in accordance with Section 01 78 23 – Operation and Maintenance Data.

#### **1.7 QUALITY ASSURANCE AND CONTROL**

1. Refer to Section 01 45 00 – Quality Control.
2. Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 – Health and Safety Requirements.

#### **1.8 PRE-QUALIFICATION CERTIFICATE**

1. Contractor shall submit the following documents with project proposal:
  1. Submit proof from manufacturer of the Contractor's good standing in the cabling manufacturer's qualification program.
  2. Submit training certificates for design, engineering and installation of the proposed products awarded to the Contractor's assigned project manager and installer. All installers working on this project shall be certified in the manufacturer's certified installers program.

#### **1.9 WARRANTY DOCUMENTATION**

1. Complete documentation regarding the manufacturer's Extended product Warranty and Application Assurance Program shall be submitted a part of the proposal. This shall include, but is not limited to, a sample of the warranty that will be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues and guaranteed performance information.
2. A system application assurance manual documenting the vendor supported applications and application guidelines shall be provided as part of the submittals.

#### **1.10 DELIVERY, STORAGE AND HANDLING**

1. Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 13 – Progress Cleaning.

### **2 Products**

#### **2.1 CATEGORY 6A CABLING MANUFACTURER**

1. Category 6A cabling products shall be selected from single manufacturer, and include, but not limited to cables, patch cords, patch panels, and associated accessories/components.
2. Approved Cabling Manufacturer:
  1. Belden.
  2. CommScope.
  3. Hubbell.
  4. Or approved equivalent.

#### **2.2 CATEGORY 6A TWISTED PAIR CABLE**

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500MHz.
2. Standard: Comply with TIA-568-D.2 for Category 6A cables.
3. Conductor: 100-ohm, 23 AWG solid copper.

4. Shielding/Screening: Unshielded balanced twisted pairs (UTP)
5. Indoor Category 6A Cable Rating: Plenum rated.
6. Indoor Category 6A Cable Color: Blue
7. Outdoor Category 6A Cable Rating: Indoor/Outdoor Rated.
8. Outdoor Category 6A Cable Color: Black
9. Patch cord and RJ-45 module jack Color-coded:

Color	Membership/Function
Blue	General Network (Data, VoIP, WAP)
Yellow	Security (Camera, Access Control)
Red	A/V
Green	911
Black	Radio

10. Operating Temperature: -40°C to +75°C.

### 2.3 UTP 4-PAIR MODULAR JACK

1. All UTP telecommunications jacks shall be Category 6A T568A, 8P8C, single, green finish, telecommunications jack with flush exit. Unless otherwise noted on the drawings, install each telecommunications jack in a single gang faceplate at each telecommunications outlet. The quantity of faceplate openings shall match the quantity of jacks at each location.
2. Install category 6A jacks at each outlet location and match in the TR at the patch panel.
3. Category 6A jack color: Refer to 2.2.7 this Section.
4. Keystone style jack.
5. In addition, Category 6A Copper Jacks must meet the following mechanical and performance criteria:
6. Exceed ANSI/TIA-568.2 Category 6A and ISO 11801 2nd Edition Class E standards.
7. Meets requirements of IEEE 802.3af, IEEE 802.3at and IEEE 802.3bt for PoE
8. Be 100% tested to ensure NEXT and RL performance and be individually serialized for traceability.
9. Color-coded, keyed jack modules mechanically and visually distinguish connections to prevent unintentional mating with unlike keyed or non-keyed modular plugs accommodating more discrete networks.
10. Have contacts plated with 50 micro inches of gold for superior performance.
11. 3rd party certified to meet the mechanical endurance to the standard requirement of IEC 60512-99-001 for support of remote power applications with test current of 2 Amperes per conductor (for future PoE++ applications). Require no punch down tool.
12. Have range to terminate 4-pair, 22 – 26 AWG, 100 ohm, solid or stranded twisted pair cable.
13. Jack wiring scheme: T568A.
14. Accept 6 and 8-position modular plugs without damage to conductor pins.
15. Identified options that include optional labels and icons.
16. Be compatible with Modular Patch Panels, Faceplates, and Surface Mount Boxes.
17. For locations with tight bend radius concerns, have optional termination caps available that allows the cable to be routed either left or right, or up or down, and not directly interfere with neighboring jacks.

18. The unshielded jacks shall be serialized such that it is visible on the connector when removed from the packaging.
19. Safety: UL 1863 listed, use as communications circuit accessory. Also investigated to UL2043, for use in air-handling spaces (plenum).

## **2.4 UTP FIELD TERMINATION PLUGS**

1. Install Category 6A UTP Field Termination RJ45 Plug at each security camera or wireless access point location.
2. Category 6A field terminable plug shall be black.
3. In addition, Category 6A UTP Field Termination RJ45 Plug must meet the following mechanical and performance criteria:
  1. Exceed ANSI/TIA-568.2-D Category 6A and ISO 11801 Class EA Channel performance requirements with up to two field termination plugs in channel.
  2. Meets or exceeds TIA Modular Plug Terminated Link requirements with up to two field termination plugs in link.
4. Compatible with 4-pair, 22–26 AWG solid or stranded unshielded twisted pair cable with conductor insulation diameters of 0.060 in. maximum and overall cable O.D. 0.200 in. to 0.330 in.
5. Meets ANSI/TIA-1096-A (formerly FCC Part 68).
6. IEC compliance: IEC 60603-7, IEC 60529 (IP 20) and RoHS compliance.
7. Meets requirements of IEEE 802.3af, IEEE 802.3at and IEEE 802.3bt for PoE applications.
8. Rated to 2500 plug mating cycles.
9. Operating temperature: -10°C to 65°C (14°F to 149°F), Storage temperature: -40°C to 70°C (-40°F to 158°F).
10. Ability to re-terminate up to 20 times with no additional parts, providing convenience and cost-savings in cases when plug must be re-terminated to cable.
11. To accommodate varying conditions with different cable bend radius concerns, have a plug with termination cap that allows the cable to be routed straight back, and a plug that allows the cable to be routed up or down, and not directly interfere with plugs above or below.
12. Safety: UL 1863 listed, use as communications circuit accessory. Also investigated to UL2043, for use in air-handling spaces (plenum).

## **2.5 UTP PATCH CORDS**

1. Factory-installed male plug at other end to mate with "RJ-45" jack to: TIA/EIA-568.2-D "RJ-45" jack Category 6A, 4 pairs, for cross-connect between the patch panel and the network switch.
2. Patch cord colors refer to 2.29 in this section.
3. All patch cords must be slim style / small diameter cable.
4. Patch cords at the termination closet end to be 1 m (4'), 2 m (7') and 3 m (10') cables, as required to reach switches from termination patch panels.
5. All patch cords at the workstation/office end to be 3 m (10'), unless otherwise noted.
6. Provide a patch cord for each end of horizontal cables shown on drawings, plus 10% spare.

## **2.6 CABLE MANAGEMENT**

1. Cable management shall be installed for each rack; 150 mm (6") wide, height matching rack, attached to each side of the rack, use 230 mm (9") cable manager where two racks are installed side by side. Include for all mounting hardware.

## **2.7 UTP PATCH PANEL**

1. Modular (RJ45) flat type patch panels.
2. Designed for high-speed data, cross connect and interconnect specifications.
3. All UTP, 4 pair, CAT6A horizontal cables shall be terminated on rack mounted patch panels; 24 or 48 ports per panel suitable for modular jacks.
4. Provide each port with a T568A (ISDN) eight pin jack as necessary to accommodate number of runs.
5. Provide patch panels in each data rack, quantity of panels as required to connect each data outlet to a corresponding patch panel port plus a minimum of 10% spare ports (based on quantity of terminated cables).

## **2.8 OPTICAL FIBER CABLING MANUFACTURER**

1. Optical fiber cabling products shall be selected from single manufacturer, and include, but not limited to cables, patch cords, patch panels, and associated accessories/components.
2. Approved Cabling manufacturer:
  1. Corning
  2. Belden
  3. CommScope
  4. Hubbell
  5. Or approved equivalent.

## **2.9 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)**

1. Description: Single mode, 9/125-micrometer, single loose tube, armored Indoor/Outdoor, OS2 optical fiber cables.
2. 12 strands as indicated on drawings.
3. Standards:
  1. Comply with TIA-492CAAB for detailed specifications.
  2. Comply with TIA-568-3.D for performance specifications.
  3. Comply with ICEA S-104-696 for mechanical properties.
4. Armored cable shall be steel armored type.
5. Maximum Attenuation: 0.5dB/km at 1310 nm; 0.5dB/km at 1550nm.
6. Cable Rating: Indoor/Outdoor rated
7. Jacket:
  1. Jacket Color: Black
  2. Number of Jackets: Double Jacket
  3. Type of Armor: Corrugated Steel Tape
  4. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
  5. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 1000 mm.

## **2.10 850 NANOMETR LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3 & OM4, AS NOTED ON COMMUNICATIONS AND SECURITY DRAWINGS)**

1. Description: Multimode, 50/125-micrometer, Indoor/Outdoor rated if outdoor for any distance, other wise indoor rated for indoor use, conductive loose tube, OM3 or OM4 optical fiber cable, as noted on drawings.
2. Strand quantity as indicated on drawings.
3. OM3 only to be used when cabling distance is less than 300 meters.

4. Standards:
  1. Comply with ICEA S-83-596 for mechanical properties.
  2. Comply with TIA-569-3.D for performance specifications.
  3. Comply with TIA-492AAAC for detailed specifications.
5. Conductive cable shall be steel armored type.
6. Maximum Attenuation:
  1. For OM3 rated cabling: 3.5dB/km at 850 nm; 1.5dB/km at 1300 nm.
  2. For OM4 rated cabling: 3dB/km at 850 nm; 1dB/km at 1300 nm.
7. Minimum Overfilled Modal Bandwidth-length Product:
  1. For OM3 rated cabling: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
  2. For OM4 rated cabling: 3500 MHz-km at 850 nm; 550 MHz-km at 1300 nm.
8. Minimum Effective Modal Bandwidth-length Product:
  1. For OM3 rated cabling: 2000 MHz-km at 850 nm.
  2. For OM4 rated cabling: 4700 MHz-km at 850 nm.
9. Cable Rating: Indoor/Outdoor rated where outdoor for any portion, otherwise indoor rated is acceptable.
10. Jacket:
  1. Jacket Color: Black if outdoor rated, aqua if indoor rated.
  2. Number of Jackets: Double Jacket (if outdoor rated).
  3. Type of Armor: Corrugated Steel Tape. Armor only required if no conduit installed.
  4. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
  5. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 1000 mm.

#### **2.11 OPTICAL-FIBER CONNECTORS**

1. All fibers shall be terminated with duplex LC type connectors with ceramic ferrule adapters to: TIA/EIA-568.1.
2. Duplex LC connectors shall be utilized.
3. Maximum insertion loss per mated connector pair shall be 0.5dB.

#### **2.12 OPTICAL-FIBER PATCH PANEL**

1. Mounted in cabinet, size as indicated on tender drawings.
2. All fiber connector panels shall be installed with duplex LC fiber adapters with ceramic sleeve and fiber designation strip. For multimode fibers, the quantity of adapters per panel shall be determined by the number of fibers being terminated.

#### **2.13 OPTICAL FIBER CONNECTOR HOUSING**

1. Single-drawer housing with space for horizontally mounted connector panels. Housing shall have slide-out drawer with label sheet, smoked shatterproof polycarbonate door with latch, and deep front shelf area to provide adequate strain relief for cables.

#### **2.14 OPTICAL-FIBER PATCH CORDS**

1. Interconnect cable, 2 strands, duplex LC to: TIA/EIA-568.3. Multi-Mode 50/125, laser-optimized, 2000 MHz km capacity, 50/125-micron laser optimized OM3/4, multimode fiber cords with flame-resistant PVC outer jacket. Patch cords shall be factory terminated and tested to 10 Gb/s data rates.

## 2.15 CABLE BUNDLING MATERIALS

1. Provide hook and loop tape, that is at least 12 mm (1/2") wide, of a length equal to 150% of the circumference of the cable bundle.
2. Tie wraps are not allowed on this project.
3. When used in areas considered environmental air spaces, all bundling materials must be appropriately listed.

## 2.16 IT CABINET

1. Approved manufacturer and part number:
  1. APC, AR3355 NetShelter SX, Server Rack Enclosure
  2. Or equivalent approved by Owner
2. Provide and install IT cabinets in the IT Room.
3. Cabinet shall be 2124mm (Height) x 750mm (Width) x 1200mm (Depth).
4. Frames are to be constructed of rugged 11 GA (0.120") steel and rigid.
5. Frames to have a minimum of 45U of useable space with 19" EIA cage nut mounting holes with permanently marked U-spacing identification.
6. Two sets of mounting rails (front and back).
7. Vertical cable management on the front of cabinet.
8. Perforated front door.
9. Split perforated rear doors.
10. Solid split side panels.
11. Color: Black
12. Casters and leveling feet.
13. Door handles and locks.
14. The cabinet roof panel to have grommet type holes for cable installation.
15. Provide 30 percent filler panels in sizes (1U, 2U and 4U) for each data cabinet.
16. Equipped with one (1) rack mounted grounding busbar for each cabinet.
17. Equipped with two (2) Vertical Cable management for each cabinet.
  1. 1981mm (Height) x 97mm (Width) x 160mm (Depth)
  2. Color: Black
  3. Mounting Mode: Rack-mounted, vertical, Front/Rear
  4. Approved manufacturer and part number:
    1. APC, AR7585 Vertical Cable Manager.
    2. Or equivalent approved by Owner.
18. Equipped with two (2) vertical managed rack Power Distributed Units (PDU) for each cabinet:
  1. Type1 PDU: 208V/30A:
    1. Fabricated from 18 GA (0.048") steel.
    2. Slim profile power bar mounted into 19" EIA cabinet frames.
    3. Color: Black
    4. PDU Type: Metered
    5. Cord Length: 1.83m (6 ft)
    6. Input Voltage: 208V 3 phase
    7. Output Voltage: 120V/208V
    8. Input Plug Type: NEMA L21-30P



9. Mounting Mode: Rack-mounted, vertical
  10. Input Current Limits: 30A
  11. Load Capacity: 8600 VA
  12. Input Frequency: 50/60 Hz
  13. Outlet Type and Quantity:
    1. 2 x NEMA 5-20R
    2. 36 x IEC 60320 C13
    3. 6 x IEC 60320 C19
  14. Approved manufacturer and part number:
    1. APC, AP8865 metered Rack PDU
    2. Or equivalent approved by Owner
2. Type 2 PDU: 208V/20A:
1. Fabricated from 18 GA (0.048") steel.
  2. Slim profile power bar mounted into 19" EIA cabinet frames.
  3. Color: Black
  4. PDU Type: Metered
  5. Cord Length: 1.83m (6 ft)
  6. Input Voltage: 208V 3 phase
  7. Output Voltage: 120V
  8. Input Plug Type: NEMA L21-20P
  9. Mounting Mode: Rack-mounted, vertical
  10. Input Current Limits: 20A
  11. Load Capacity: 5760 VA
  12. Input Frequency: 50/60 Hz
  13. Outlet Type and Quantity:
    1. 36 x NEMA 5-20R
  14. Approved manufacturer and part number:
    1. APC, AP8862 metered Rack PDU
    2. Or equivalent approved by Owner
3. Type 3 PDU: 120V/208V/30A PDU:
1. Fabricated from 18 GA (0.048") steel.
  2. Slim profile power bar mounted into 19" EIA cabinet frames.
  3. Color: Black
  4. PDU Type: Metered
  5. Cord Length: 3.00m (9.84 ft)
  6. Input Voltage: 120V/208V
  7. Output Voltage: 120V
  8. Input Plug Type: NEMA L14-30P
  9. Mounting Mode: Rack-mounted, vertical
  10. Input Current Limits: 30A
  11. Load Capacity: 4992 VA
  12. Input Frequency: 50/60 Hz
  13. Outlet Type and Quantity:
    1. 16 x NEMA 5-20R
    2. 12 x IEC 60320 C13
    3. 2 x IEC 60320 C19
  14. Approved manufacturer and part number:
    1. APC, AP8870 metered Rack PDU
    2. Or equivalent approved by Owner

### **2.17 12-CHANNEL NETWORK SURGE PROTECTOR**

1. To be installed in the IT cabinet to provide surge protection for outdoor cameras.
2. 12-channel, 1U, 19" rack mount
3. Service Voltage: <60V
4. Protection Modes: Common (All), Differential (All)
5. Clamping Voltage: Common Mode: 75V, Differential Mode: 7.22V
6. Surge Current Rating: 20KA/pair
7. Power Handling: Up to 144 Watts
8. Data Rate: Up to 10GbE
9. Connection Method: Shielded RJ45 Female In/Out
10. Operating Temperature: -40°C - 70°C
11. Dimensions: 483mm (L) x 70mm (W) x 45mm (H)
12. Approved manufacturer and part number:
  1. DITEK, DTK-RM12NETS
  2. Or equivalent approved by Owner.

### **2.18 WI-FI SYSTEM**

1. Contractor to provide CAT6A cabling, termination, backbox, pull boxes, j-hook/conduits, and pathways as per design documents.
2. Wireless access points and headend equipment to be provided, installed, and tested by Contractor.

## **3 Execution**

### **3.1 INSTALLATION AND INSPECTION - GENERAL**

1. The equipment/products shall be installed as indicated on the Contract Drawings and these specifications, in accordance with the Manufacturer's recommendations and as approved by the Engineer.
2. Provide the services of a factory trained representative(s) to inspect, operate, test, adjust, and troubleshoot the installations.
3. Inspection to include checking for:
  1. Cracks and other damaged or defective parts. Each equipment/products, as well as accessories, must be undamaged, without cracks and free of defective parts.
  2. Completeness of installation as specified and as recommended by the Manufacturer.
  3. Correctness of setting, alignment, and relative arrangement of various parts of the system.
4. Provide for additional supervision of installation by Equipment Manufacturer as required. Arrange with the Engineer a mutually agreeable date when the representative should be on site.
5. Complete on-site testing (and off-site testing where specified) and provide the results of the tests.
6. Submit a report, signed by the Manufacturer's representative, describing in detail the inspection, tests, and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance. The report must verify that the equipment/products conform to all specifications.

### **3.2 SUPERVISION OF INSTALLATION AND COMMISSIONING - GENERAL**

1. Provide commissioning and startup in accordance with these specifications.

2. At the completion of satisfactory installation, each unit shall be started by the Contractor under the supervision of the Manufacturer and in conjunction with plant operating conditions.
3. Equipment/products shall only be accepted after receipt of a satisfactory report submitted by the Manufacturer's representatives.
4. Modify or replace equipment/products failing required tests.
5. Perform additional testing required due to changes of equipment/products and/or failure of equipment/products or construction to meet specifications at no extra cost to the Owner.

### **3.3 PERFORMANCE TESTS - GENERAL**

1. Complete on-site testing (and off-site testing where specified) and provide the results of the tests, all in accordance with the timelines and requirements listed in Section 01 45 00 – Quality Control and these specifications.
2. The field service representative(s) shall submit to the Engineer a written report stating that the equipment/products have been checked and is suitable for operation.

### **3.4 INSTALLATION OF TERMINATION AND CROSS-CONNECT HARDWARE**

1. Install termination and cross-connect hardware on wall, in cabinet as indicated and according to manufacturers' instructions. Identify and label as indicated to: TIA/EIA-606-D.

### **3.5 INSTALLATION OF HORIZONTAL DISTRIBUTION CABLES**

1. Install horizontal cables in conduits or cable trays from telecommunication spaces to individual work-area jacks. Identify and label as indicated to: TIA/EIA-606-D.
2. Terminate horizontal cables in telecommunications room and at individual work-area jacks.
  1. Identify and label as indicated to: TIA/EIA-606-D.
3. Coil spare cables and store in ceiling space in zone.
4. Harness slack cable in cabinets, racks, and wall-mounted termination and cross-connection hardware.

### **3.6 INSTALLATION OF EQUIPMENT CABLES**

1. Install equipment cables from equipment patch panel as indicated.
  1. Identify and label as indicated to: TIA/EIA-606-D.

### **3.7 IMPLEMENT CROSS-CONNECTIONS**

1. Implement cross-connections using patch cords as specified.

### **3.8 TESTING/WARRANTY**

1. Copper Cable testing
  1. Testing of all copper wiring shall be performed prior to system acceptance.
  2. One hundred percent of the permanent installed links shall be tested for conformance to the manufacturers guaranteed performance levels as specified in the manufacturer's Extended Product Warranty platform.
    1. Any pairs not meeting or exceeding the requirements of the guaranteed performance levels shall be brought into compliance by the contractor, at no charge to the owner.
    2. All cabling shall exceed the specifications of ANSI/TIA-568.2-D (specific to the Category standards the cabling is manufactured to) by the margins (headroom) specified in the manufacturer's Extended Product Warranty platform.
  3. One hundred percent of the backbone cabling pairs shall be tested for opens, shorts, polarity reversals, transposition, and presence of AC voltage.

4. All test equipment shall be updated with the latest firmware and software releases available from the manufacturer of the test equipment.
5. All test equipment shall include valid proof of calibration within 6 months of the testing date. The calibration shall utilize the manufacturer's recommended calibration practices.
6. Backbone/riser cables rated above Category 5e shall be tested according to test set manufacturer's instructions utilizing the latest firmware and software.
  1. Testing shall include all the electrical parameters.
  2. The detailed test results shall include the following:
    1. Wire Map.
    2. Length.
    3. Insertion loss.
    4. Near-End Cross Talk (NEXT).
    5. Power Sum Near-End Crosstalk (PSNEXT).
    6. Equal-Level Far End Crosstalk (ELFEXT).
    7. Power Sum Equal-Level Far-End Crosstalk (PSELFEXT).
    8. Return Loss.
    9. Propagation delay.
    10. Delay skew.
  7. Complete, end to end, test results must be submitted to Owner's Representative for review.
2. Optical Fiber Cable Testing
  - .1 All fiber testing shall be performed on all fibers in the completed end to end system.
  - .2 Testing shall consist of a bidirectional end to end OTDR trace performed per EIA/TIA 455-61 or a bidirectional end to end power meter test performed per EIA/TIA 455-53A. Optical Certification testers may be used if approved in advance by the Owner's Representative.
  - .3 The system loss measurements shall be provided at (850 and 1310 nanometers for multimode fibers) and (1310 and 1550 for single mode fibers).
  - .4 Pre-installation cable testing
    1. The Contractor shall test all fiber cable prior to the installation of the cable and provide Owner's Representative with those test results prior to installation.
    2. The Contractor shall assume all liability for the replacement of the cable should it be found defective.
  - .5 Loss Budget
    1. Fiber links shall have a maximum loss of: Allowable cable loss per km) (km of fiber in link) + (.4dB) (number of connectors) = maximum allowable loss
    2. Maximum 0.3 dB for splice, 0.5 dB for mating connectors if required.
    3. A mated connector to connector interface is defined as a single connector.
    4. Any link not meeting the requirements of the standard shall be brought into compliance by the Contractor, at no charge to Owner.
    5. Documentation shall be provided in electronic form to Owner's Representative.
  - .6 Complete, end to end, test results must be submitted to Owner's Representative for review (provide both PDF format and native tester file format).
3. Extended Product Warranty Work
  1. Under the Extended Product the manufacturer shall replace any and all defective product or product not functioning to the levels guaranteed at the time of the warranty issue at the manufacturer's cost.
  2. The manufacturer shall engage an authorized manufacturer's reseller to repair or replace any such defective product on behalf of the manufacturer at no cost to the Owner.

3. The Extended Product Warranty shall include a minimum one (1) year installation warranty for the premises copper and optical cabling to correct all installation related problems/issues at no cost to the Owner.
4. Replace cable and/or connection equipment that fails tests.
5. Provide additional testing in accordance where required by Owner's Representative.
6. Provide record of results as electronic record to: TIA/TSB-140.

### **3.9 STORAGE**

1. Prior to installation, the equipment/products and accessories shall be protected and stored indoors in a dry area, in accordance with the Manufacturer's recommendations.

### **3.10 OPERATION AND MAINTENANCE (O&M) DATA**

1. Submit Operation and Maintenance (O&M) Data for all equipment/products in this Section in accordance with Section 01 78 23 – Operation and Maintenance Data.  
Training
2. Unless otherwise specified, provide Demonstration and Training in accordance with Section 01 78 23 – Operation and Maintenance Data.

**END OF SECTION**

## **1 General**

### **1.1 RELATED REQUIREMENTS**

1. Division 26 – Electrical:
  1. Section 26 05 34 – Conduits, Conduit Fastenings, and Conduit Fittings.
2. Division 27 – Communications:
  1. Section 27 05 26 – Grounding and Bonding for Communications Systems.
  2. Section 27 05 28 – Pathways for Communications Systems.

### **1.2 SUBMITTALS**

1. Submit in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data:
    1. Submit manufacturer's instructions, printed product literature and data sheets for intercommunications systems and include product characteristics, performance criteria, physical size, finish and limitations.
    2. Include riser diagram, talk paths of complete intercom system.
  3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria, and as follows:
    1. Construction Waste Management:
      1. Submit project Waste Management Plan highlighting recycling and salvage requirements in accordance with Section 01 74 19 – Construction Waste Management.

### **1.3 CLOSEOUT SUBMITTALS**

1. Submit in accordance with Section 01 78 23 – Operation and Maintenance Data, and as follows:
  1. Operation and Maintenance Data: submit operation and maintenance data for intercommunications systems for incorporation into manual.
  2. Include parts list using component identification numbers standard to electronics industry.
2. Extra Materials:
  1. Provide maintenance materials in accordance with Section 01 78 23 – Operation and Maintenance Data.

### **1.4 DELIVERY, STORAGE AND HANDLING**

1. Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements and with manufacturer's written instructions.
2. Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
3. Storage and Handling Requirements:
  1. Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  2. Store and protect intercommunications systems from nicks, scratches, and blemishes.
  3. Replace defective or damaged materials with new.
4. Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 35 43 – Environmental Procedures.

## 2 Products

### 2.1 INTERCOM VIDEO MASTER STATIONS

1. Provide Intercom video master stations at all locations indicated on the Security Drawings.
2. Minimum Specifications:
  1. Power Source: 24 VDC.
  2. Consumption: 340 mA (Max).
  3. Communication:
    1. Handset: Simultaneous communication.
    2. Hand-free: Auto-voice actuation.
  4. Monitor: 7" TFT touchscreen LCD
  5. Pixels: 800 x 480
  6. Picture memory:
    1. Internal: 20
    2. External: 1,000 using SD/SDHC card.
  7. Picture protect:
    1. Internal: 5
    2. External: 100
  8. Mounting:
    1. Surface wall mount
    2. Desk mount
  9. Operating temperature: 0°C to 40°C (32°F to 104°F).
3. Approved manufacturer and part number:
  1. Manufacturer: Aiphone
  2. Part Number: JP-4MED

### 2.2 INTERCOM VIDEO DOOR STATIONS

1. Provide intercom video door stations at all locations indicated on the Security Drawings.
2. Minimum Specifications:
  1. Power Source: Supplied from JP series Master Station.
  2. Communication: Hand-free.
  3. Camera: CMOS
  4. Min. illumination: 5 lux.
  5. Camera angle: Wide (approx. 170°) with digital PTZ.
  6. Wiring: 4-conductor, PE insulation,
  7. Wiring Distance: 100m (330')
  8. Operating temperature: -20°C to 60°C (-4°F to 140°F).
3. Approved manufacturer and part number:
  1. Manufacturer: Aiphone
  2. Part Number: JP-DVF

### 2.3 DC 24V POWER SUPPLY

1. Provide DC 24V power supplies for intercom video master stations at all locations indicated on the Security Drawings.
2. Minimum Specifications:
  1. Power Input: AC 100~240V, 50/60Hz
  2. Power Output: DC 24V, 2A

3. Power Consumption: 110~140VA
4. Temperature rating: 0°C to 40°C (32°F to 104°F).
5. Wiring connection: Screw terminals.
3. Approved manufacturer and part number:
  1. Manufacturer: Aiphone
  2. Part Number: PS-2420

## **2.4 INTERCOM CABLING**

1. 4-pair, unshielded, #23 AWG, Category 6A cable
  1. To be installed between intercom video master stations as indicated on the security drawings.
2. 4-conductor, stranded, unshielded, #18 AWG cables
  1. To be installed between intercom video master station and door station, and between intercom video master station and electric strike for door releasing as indicated on the Security drawings.

## **2.5 INTERCOM INSTALLATION ANCILLARY DEVICES**

1. Provide all ancillary devices for a complete operational system. Provide all system software and programming by manufacturer's authorized and trained technician.
2. Provide all system modules, mounting kits, flush and surface mount boxes and mounting hardware. Provide all wiring and cables for a complete and operational system.
3. Ancillary devices to be of type in accordance with equipment manufacturer's requirements. Wiring to also be in accordance with applicable local governing codes and standards.

# **3 Execution**

## **3.1 EXAMINATION**

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

## **3.2 INSTALLATION**

1. Install equipment as indicated and in accordance with manufacturer's instructions.
2. Interconnect system components.
3. All intercom cabling shall be wired in conduit or cable tray systems.

## **3.3 TESTS**

1. Perform tests in accordance with Section 26 05 00 – Common Work Results for Electrical.
2. Conduct performance test.

## **3.4 CLEANING**

1. Progress Cleaning: clean in accordance with Section 01 74 13 – Progress Cleaning.
  1. Leave Work area clean at end of each day.
2. Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 23 – Final Cleaning.



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

### 3.5 PROTECTION

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

**END OF SECTION**

## 1 General

### 1.1 RELATED REQUIREMENTS

1. Division 26 – Electrical:
  1. Section 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings.
2. Division 27 – Communications:
  1. Section 27 05 26 - Grounding and Bonding for Communications Systems.
  2. Section 27 05 28 - Pathways for Communications Systems.
3. Division 28 – Electronic Safety and Security:
  1. Section 28 23 00 – CCTV Video Surveillance.
  2. Section 28 31 00 – Intrusion Alarm Systems.

### 1.2 REFERENCE STANDARDS

1. The equipment, materials and installation for the Access control System (ACS) shall comply and conform to the latest version of the following applicable codes, standards (including technical service bulletins and Addenda), guidelines, reference handbooks, and regulations of authorities having jurisdiction (AHJ):

CSA C22.1 1-2018, 24 <sup>th</sup> Ed.	Canadian Electrical Code, Part I.
OESC 2015, 26 <sup>th</sup> Ed.	Ontario Electrical Safety Code.
OBC 2015 Ed.	Ontario Building Code.
ITSG-11A	COMSEC Installation Planning – Guidance and Criteria
ANSI/TIA-569-D	Telecommunications Pathways and Spaces.
ANSI/TIA-607-C	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
ANSI/TIA-606-C	Administration Standard for Telecommunications Infrastructure.
ANSI/TIA-968-B-2016	Technical Requirements for Connection of Terminal Equipment to the Telephone Network
IEEE/ANSI C63.4 / IEEE/ANSI C63.10	Wireless Devices and Radio Noise Emissions Package
ICES-003-2014	Information Technology Equipment (ITE) — Limits and Methods of Measurement for Discussion — Data Breach Notification and Reporting Regulations
UL 60950-1	Information Technology Equipment – Safety

### 1.3 DEFINITIONS

1. “ACS” shall mean Access Control System. It includes (but not limited to) the ACS Panel with Door Controllers, ACS Server, ACS Monitor, ACS Software Licenses, Power Supplies, Batteries, Door Contacts (DC), Card Readers (CR), Keypad (KP), Electric Strikes (ES), Request-to-Exit (REX) with Motion Detectors, Request-to-Exit Switch (RX), Security Wiring, Security Conduit System, System Programming Manual, System Operation Manual, and Training Manual.
2. “IAS” shall mean Intrusion Alarm System. It includes (but not limited to) the IAS Main Control Panel (with 8-board zones), IAS Server, IAS Monitor, IAS Software Licenses, Control Cabinet, Lock-keys, Power Supplies, Batteries, Motion Detectors, Glass break Detectors, Security Wiring System, Security Conduit System, System Programming Manual, System Operation Manual, and Training Manual.
3. “CCTV” shall mean IP Closed Circuit Television. The CCTV includes (but not limited to) the PoE/IP-based Cameras, Video Management System (VMS), CCTV Server, CCTV Monitor, CCTV Software Licenses, Cat6A Structured Cabling System (SCS), Security Conduit System, Pull Boxes, System Programming Manual, System Operation Manual, and Training Manual.

4. "SBB" shall mean Secondary Bonding Busbar. There is typically one SBB per Main Equipment Room (MER), and Telecom Room (TR). The SBB is connected both to the Primary Bonding Busbar (PBB) and to building structural steel or other permanent metallic systems.
5. "N.I.C" shall mean Not in Contract.

#### 1.4 SYSTEM DESCRIPTION – SCOPE OF WORK

1. the Security Contractor is to provide a functionally complete ACS consisting of the following equipment, software, programing, and all accessories to make a complete and operative ACS described herein.
  1. Provide ACS Control Panels with door controllers (4-door controllers) including 1xEthernet port, and 1xRS-485 interface with Advanced Encrypted Standard (AES) protocol. For the ACS layout floor plans, ACS riser, and door elevations; refer to the drawings.
  2. Provide all ACS required hardware such as: ACS Servers, ACS Monitor, Power Supplies, Transformers, Batteries, Card Readers (CR), Keypads (KP), and all ACS Security Devices (REX, ML) as required.
  3. Provide separated door contacts (DC) for the ACS and IAS systems.
  4. All CR and KP devices are to be connected with the ACS panels through 3-Pair, 22 AWG, shielded as it is within 1000' (305 m) of the ACS panel. For the wiring system details, refer to the cable legend on drawings.
  5. Provide the ACS Security Management Software (SMS) Suite including the Configuration Software, Remote System Management (RMS), ACS Software Licenses for local/remote diagnostics, inspections/maintenance, and Web-based System Administrator Software for professional end-user system administration.
  6. The ACS shall be able to accommodate test, diagnostics, and configuration programming functions locally or remotely via a portable programmer or a computer running the ACS SMS.
  7. The ACS shall annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English, and French-Canadian texts.
  8. The Electrical Contractor (Division 26) shall provide all end-to-end security conduit system for the ACS. For conduit details, refer to the Section 26 05 34 and 27 05 28 Specifications.
  9. The Security Contractor is to integrate the ACS with the existing and new security systems: ACS, IAS, and FAS systems as per Owner requirements. The Security Contractor is to coordinate with related disciplines to integrate required security systems.

#### 1.5 QUALITY ASSURANCE - CERTIFICATION

1. Manufacturer Qualification:
  1. The ACS system manufacturer shall have been in business manufacturing similar products for at least 5 years.
  2. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standards.
2. Installer Qualification:
  1. The Security Contractor shall be registered as a Certified Security Installer for the installation and maintenance of the ACS system from the preferred/selected security Manufacturer(s). The Security Contractor shall have at least five years of experience installing ACS, IAS, CCTV, and security systems.
  2. All ACS products are to be by a single Manufacturer unless otherwise stated in this document.
  3. The Security Contractor selected for this project must provide a Manufacturer's Certification Number to confirm training received from the manufacturer (s) prior to start of work.
  4. The Security Contractor shall engage manufacturer for commissioning and certifying of manufacturers' equipment hardware and software two weeks prior to substantial completion of work.
  5. The Security Contractor shall be factory-trained and certified to maintain/repair the system after system acceptance.

## 1.6 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data:
    1. Submit manufacturer's instructions, and data sheets for the ACS software, ACS control panels, cabinets/enclosures, power supplies, low-voltage transformers, batteries, ACS security devices (CR, KP, REX, RX, etc.) including product features, performance criteria, physical size, finish and limitations.
    2. Submit the following documents:
      1. Functional description of equipment.
      2. Technical datasheets for all security devices.
      3. ACS wiring/cabling schedule lists.
      4. Devices mounting location detail drawings.
      5. Typical devices connection detail drawings.
  2. Shop Drawings:
    1. Shop drawings to indicate security device location, mounting height and location of the keypad on drawings, detail wiring diagrams, etc.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

## 1.7 CLOSEOUT SUBMITTALS

1. Operation and Maintenance (O&M) Data: Submit maintenance data for incorporation into the O&M manual.
  1. Include:
    1. ACS system configuration and equipment physical layouts.
    2. ACS functional description of equipment.
    3. Instructions for the O&M of equipment.
    4. Illustrations and diagrams to O&M supplement procedures.
    5. O&M instructions provided by manufacturer.
  2. Manufacturer's Instructions: Submit manufacturer's installation instruction manuals.
  3. Manufacturer's Field Reports: Submit manufacturer's written reports within five (5) days of review, verifying compliance of work.
  4. As-built Records and Drawings.

## 1.8 DELIVERY, STORAGE AND HANDLING

1. The Security Contractor shall responsible for the storage and handling of all materials required by the ACS.
2. Storage and Protection: Any materials that show signs of mishandling or have been stored in a fashion so as to reduce the value of the materials shall be replaced with new materials at no additional cost to Owner.
3. Protect store materials from environmental and temperature conditions following manufacturer's instructions. Handle and operate products and systems according to manufacturer's instructions.
4. Deliver materials in manufacturer's original, unopened, undamaged containers, and unharmed original identification labels.
5. Waste management and disposal procedures.

## 1.9 SITE CONDITIONS

1. During the ACS installation, testing, and commissioning process; the Security Contractor shall maintain the environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

## 1.10 WARRANTY

1. All components, parts, and assemblies supplied by the manufacturers and installed by the Security Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.
2. Extended warranty, up to five (5) years, shall be available through the purchase of a software maintenance agreement (SMA) which includes the following additional services over the standard warranty:
  1. Access to phone support and online chat for technical assistance.
  2. Online case management.
  3. Online system availability monitor.
  4. Access to Major and Minor Release Upgrades.
  5. 24/7 technical support and dedicated support specialist.
3. Service/Maintenance:
  1. System maintenance and repair of the ACS system or workmanship defects during the warranty period shall be provided by the Security Contractor free of charge (parts and labor)
  2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
  3. The Security installer shall correct any system defect within six hours of receipt of call from the Owner.
  4. Extended service/maintenance agreements shall be offered by the Security Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

## 1.11 PREFERRED MANUFACTURERS

1. ACS products/materials are to be equal, or equivalent to the following preferred manufacturer list, below.

Products/Materials	Preferred Manufacturers
ACS Control Panels	HID Mercury
ACS Security Management System (SMS) Software	HID Mercury
Card Reader	HID
Card Reader with integrated Keypad	HID
Power Supplies	Altronix
Cabinets/Enclosures	HID, Altronix
Accessories (REX, Door contact, etc.)	Bosch, GE Security
ACS & IAS Servers and Workstations	Dell, HP
Badge & ID Card Printer	Fargo

## 2 Products

### 2.1 MATERIALS

1. Manufacturer:
  1. All ACS products are to be by a single approved Manufacturer unless otherwise stated in this document.
2. Material and equipment: The ACS will have the following components.

Item	Description	Type	Notes
1	Door Controllers	ACS Controller	Quantities as required.
2	I/O Expander Modules	ACS Expanders	Quantity as required.
3	Power Supplies	Power Supply	Quantity as required.
4	Transformer (16V, 40VA)	Power Supply	Quantity as required.
5	Batteries (12V, 7A)	Battery	Quantity as required.
6	Smart Card Reader, multi-technology, mullion with integrated Keypad and tamper switch.	Card Readers and Keypads	Quantity as required.
7	Request-to-Exit with Motion Detector (REX)	Device Control	Quantity as required.
8	Internet and HSPA Dual-Path Alarm Communicator	Device Interface	Quantity as required.
9	ACS Control Cabinet / Enclosures	ACS Main Controller	Quantities as required.
10	Accessories (Door Contact, Tamper Switch / Detector, etc.)	Various	Quantities as required.

### 2.2 DOOR CONTROLLER

1. Provide door controller licenses as required.
2. HID Mercury Door Controller or approved equivalent approved by Owner.

### 2.3 INPUT/OUTPUT CONTROLLER

1. All input/output controllers shall have the following minimum features:
  1. Connects to the network controller via RS-485, Ethernet or RS-232
  2. line supervision
  3. Multiple programmable supervised or non-supervised contacts
  4. 2 dedicated inputs for tamper and power failure load switching
  5. selectable addressing
  6. Status LED for host communication

### 2.4 CARD READERS - MULTICLASS TYPE

1. Provide ACS contactless card readers at locations indicated on the Security Drawings. Card readers shall meet, at minimum, the following requirements:
  1. Manufacturers or supplier's visible identification logo or trademark is not permitted.
  2. Multi-colour LED displaying green upon a valid read, red upon invalid read or normal at rest mode.
  3. Appropriate colour matching location finish.

4. Environmentally protected on exterior applications.
  5. Contactless smart card interactive type.
  6. 125 KHz and 13.56 MHz transmit frequency.
  7. Exchange credential and authentication information with the PACS controller using OSDPv2.
  8. Terminal strip panel connection.
  9. Read range of 50 mm (2") for building applications.
2. Installation of card readers shall meet, at minimum, the following requirements:
  1. Tamper resistant.
  2. Complete with any faceplates or trim that may be required. Provide standoff non-metallic (e.g. ½ inch Lexan with rounded edges) plates to prevent interference when mounted on metal walls, pedestals or building components.
  3. Damage by static electricity or mechanical shock is avoided. Provide grounding as required.
3. Provide contactless smart card technology card readers at locations indicated on the Security Drawings. Types are as follows:
  1. Type 1 – Interior or exterior proximity card technology card reader HID multiCLASS SE RP40 series.
  2. Type 2 – Interior or exterior mullion or slim type contactless proximity card technology card reader HID multiclass SE RP10 or RP15 series (for high finish or small form factor locations, such as elevator cabs).

## 2.5 CREDENTIALS

1. Access cards will be supplied by the Owner.

## 2.6 DOOR CONTACT

1. Door contacts for security doors shall be provided and terminated.
2. Provide and terminate door status sensors from the control panel to the mounting location at the door.
3. Door contact shall be recessed mounted, either 3/4" or 1" in diameter.

## 2.7 REQUEST TO EXIT DEVICE

1. Supply and install request to exit device and signal cabling as per drawings.
2. Request to exit motion detectors shall be programmed not to release the electric strike upon motion detection. The request to exit shall act as a door position alarm shunt upon motion detection only.

## 2.8 POWER SUPPLY

1. Power supplies shall include but not limited to all controller power supplies, all electric lock power supplies and all peripheral device power supplies.
2. All controller and peripheral device powers supplies shall provide back-up battery for up to eight (8) hours operation upon loss of AC power. The controller shall provide capacity to retain database information for up to seven days upon loss of power.
3. Agency Listings
  1. UL Listed for Access Control Systems (UL294),
  2. Power Supplies for use with Burglar-Alarm Systems (UL603),
  3. Hospital Signaling and Nurse Call Equipment (UL1069),
  4. Power Supplies for Fire Protective Signaling Systems (UL1481),
  5. CUL Listed - CSA Standard C22.2 No.205-M1983, Signal Equipment.
4. Features/Specifications

1. Voltage: output as required.
  2. Amperage: Rating as required.
  3. Class 2 Rated power limited outputs.
  4. PTC (Positive Temperature Coefficient) protected outputs.
  5. Fuse rating as required
  6. 115VAC 60Hz, input.
  7. Filtered and electronically regulated outputs.
  8. Short circuit and thermal overload protection.
  9. Built-in charger for sealed lead acid or gel type battery backup.
  10. Zero voltage drop upon transfer to battery backup.
  11. AC input and DC output LED indicators.
  12. AC fail supervision.
  13. Low battery and battery presence supervision.
  14. Fire alarm system interface as required.
5. Power Supply for Electric Strikes shall be Altronix AL600ULPD8CD or approved equal.

## **2.9 ACCESS CONTROL PANELS/ENCLOSURES**

1. All access control panels/enclosures shall be provided to house all controllers.
2. All access control panels/enclosures shall be a single key locking metal box.
3. Size as required
4. Equipped with door tamper switch. Connect each door tamper switch to the access control system.
5. The quantity and size of access control panels/enclosures shall not exceed the real estate provided for mounting access control panels/enclosures. Refer to contract drawings and coordinate as such.
6. All access control panels shall be installed on plywood backboards in locations indicated on the tender drawings.

## **2.10 ELECTRIC LOCKS**

1. Electric door locking hardware (electric mortise locks, electric strikes, etc.) shall be provided by the security contractor.
2. Coordinate lock and door hardware with the general contractor and all door hardware subcontractors and review each security device location as shown on the Security Drawings to ensure the proper door hardware is provided at required locations.
3. A licensed or certified locksmith shall be retained by the security contractor if required to perform accurate field preparation of doors and frames.
4. Any doors and frames rendered faulty by unqualified door and frame preparation by the security contractor shall be repaired/replaced at no additional cost to the Owner.
5. Provide and terminate relay output cabling from the control panel to the electric door locking hardware.
6. Electronic locking devices shall have a separate power supply to support the locks specified below. The unit shall incorporate integral battery charging capabilities and a fused line voltage input for a minimum of eight (8) individual locks. All power supplies shall be equipped with optional battery pack for up to eight (8) hours. The unit shall be equipped with a fire alarm system interface as required.

## **2.11 ACCESS CONTROL CABLING**

1. Provide access control composite cable (standard distance), CMP –Belden Banana Peel Type 658AFJ or approved equal, and shall meet distance requirements from control panel to end device.



1. Card Reader: 6C/22AWG, Stranded, Shielded
2. Electric Strike: 4C/18AWG, Stranded, Shielded
3. REX: 4C/22AWG, Stranded, Shielded
4. Door Contact: 4C/22AWG, Stranded, Shielded
5. Inner Shield Material: Aluminum / PVC
6. Inner Jacket Material: PVC-Low Smoke
7. Outer Jacket Material: PVC-Low Smoke with ripcord
8. Temperature 0°C to 75°C
9. Voltage Rating: 300V (CMP)

## **2.12 ACS & IAS REDUNDANT SERVERS AND PERIPHERALS**

1. Provide 1 x set of redundant servers (2 x Servers, 2 x Monitors, 2 x Peripheral) for the ACS and IAS systems. Both servers have to have positive control at all time in the case one server goes down; another server is to be able to failover for all ACS and IAS functionalities. Each server has to be installed with combined ACS and IAS security management systems.
2. Server and Peripheral Technical Features:
  1. Mounting: Rack Mount Servers (preferable 1U),
  2. Microprocessor: Intel Multi Core Xenon family,
  3. Operating System: Microsoft Windows Server
  4. Hard Drive: 1TB,
  5. RAM Memory: 16 GB,
  6. LAN Interface: 10/100/1000 Gigabit NIC,
  7. Flat Screen Monitors: 27", HD (1920 x 1080 p)
  8. Keyboard: Standard Multimedia,
  9. Mouse: Optical.

## **2.13 ACS & IAS HARDWARE & WORKSTATION**

1. Provide 1 x workstation. The ACS workstation is composed by 1 x computer, 1 x monitor, 1 x keyboard, and 1 x mouse including the operating system and required ACS client software licenses.
2. The ACS & IAS workstations are to be able to monitor/search/investigate security issues and manage permissions at this external location.
3. Workstation Technical Features:
  1. Mounting: Rack Mount
  2. Microprocessor: Intel Core i7 family,
  3. Operating System: Windows 10 Pro, 64bit
  4. Hard Drive: 500GB,
  5. RAM Memory: 12 GB,
  6. LAN Interface: 10/100/1000 Gigabit NIC,
  7. Flat Screen Monitor: 27", HD (1920 x 1080 pixels)
  8. Keyboard: Standard Multimedia,
  9. Mouse: Optical

## **2.14 BADGE & ID CARD PRINTER**

1. Provide 1 x ID Card Printer including ID card Software.
2. ID Printer Technical Features:
  1. Fast dye: sublimation printing,
  2. Card size support: 9 mil to 40 mil thickness,
  3. Full colour: edge-to-edge printing

## **2.15 ACS SECURITY MANAGEMENT SYSTEM (SMS) SOFTWARE**

1. The ACS SMS shall be an enterprise class IP access control software solution.

2. The ACS SMS shall be highly scalable to support configurations consisting of thousands of doors with facilities spanning multiple geographic areas.
3. The ACS SMS shall support an unrestricted number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.
4. The ACS SMS shall support a variety of access control functionalities, including but not limited to:
  1. Controller (Unit) management, door management, elevator management, and area management.
  2. Cardholder and cardholder group management, credential management, and access rule management.
  3. Badge printing and template creation. Optionally allowing authorized users the ability to search for persons by name and view associated person records; then linking photographs taken of a person by a camera on a mobile device to the record. The ACS SMS associated record and photo can be later badge printing.
  4. Visitor Management and/or integrate with a variety of industry leading visitor management products.
  5. People/occupancy counting, area presence tracking, and mustering.
  6. A framework for third party hardware integration including the hardware and Intrusion control panels.
  7. The ACS SMS shall support a direct connection to a Microsoft Active Directory (AD) Domain Controller servers.
  8. The ACS shall support cardholder management and user logon management through AD.
  9. The ACS shall support Active Directory group nesting.
  10. The ACS SMS shall support the use of Threat Level Management to dynamically alter the security system behavior. A visible notification shall be displayed to all interactive systems users when a threat level is activated. This is a software integration feature.
  11. The ACS SMS shall allow each geographical location, full autonomous control and management of the system at its location.
  12. The ACS SMS shall support a Global Management functionality that merges independent autonomous installation into a single large virtual system for centralized monitoring, reporting and alarm management. Global Management shall be a security application enabling system operators and administrators to monitor multiple distributed independent installations simultaneously.
  13. The ACS SMS will allow monitoring and control through a web browser interface.
  14. The ACS SMS shall be compatible with virtual environments.
  15. The ACS SMS shall provide a standard, centralized way for the application to record important software and hardware events, including but not limited to access granted, access denied, all door actions, alarms & events, all Operator actions, permission changes, as well as hardware and software errors.
  16. The ACS SMS application shall provide the ability to run report on important software and hardware events, including but not limited to access granted, access denied, all door actions, alarms & events, all Operator actions, permission changes, as well as hardware and software errors.
  17. The ACS SMS shall provide the ability for end users to visualize their security environment by providing mapping functionality. Maps shall have the ability to display system entities such as doors, digital inputs, digital output, intercoms and alarms, and it shall be possible to monitor the state of and interact with all entities on the map.

## 2.16 ACS SMS SOFTWARE FEATURES

1. The ACS SMS shall be an IP enabled solution. All communication between the ACS and the Access Control Remote Device hardware's intelligent controllers shall be based on standard TCP/IP and RS-485 protocol.

2. Technical Features:

1. The ACS software shall fully support the capabilities of all ACS devices.
2. The ACS shall support the configuration and management of IP enabled controllers and Input/output (IO) modules (hardware units). A user shall be permitted to add, delete, or modify a controller if he or she has the appropriate privileges.
3. The ACS software shall synchronize all access control hardware units under its control, such as door controllers and IO modules. It shall also be able to validate and log all access activities and events when the door controllers and IO modules are online.
4. The ACS software shall maintain the communication link with the hardware controllers under its control. It shall also continuously monitor whether the controllers are online or offline.
5. Synchronization of hardware units shall be automated and transparent to users and shall occur in the background. It shall also be possible to manually synchronize units or to synchronize units on a schedule
6. The ACS software shall support doors and controllers located within one or more facilities.
7. The ACS software shall store all access events associated with the doors, areas, hardware zones (hardware input points), elevators, and controllers under its direct control.

**2.17 ACS DOOR MANAGEMENT**

1. The ACS shall support the configuration and management of doors. A user shall be able to add, delete, or modify a door if he or she has the appropriate privileges.
2. The ACS shall permit multiple access rules to be associated to a door.
3. The ACS shall support the following forms of authentication: Card Only, Card or Keypad (PIN), or Card and Keypad (PIN). It shall be possible to define a schedule for when Card Only or Card and Keypad authentication modes shall be required.
4. It shall be possible to set an extended grant time on a per-door basis (in addition to the standard grant time). Cardholder properties shall include the option of using the extended grant time. When flagged cardholders are granted access, the door shall be unlocked for the duration of the extended grant time instead of the standard grant time.
5. The ACS shall allow the configuration of the relocking mode on doors such as on door open, after a definite time, or on door close.
6. The ACS shall support the ability to enforce the use of two valid reads within a specified number of seconds from different cardholders to grant access to an area.
7. The ACS shall support the ability to enable access rules for other cardholders once a supervisor has accessed an area.
8. The ACS shall support the ability to enable unlocking schedule on a door once an employee has entered the facility.
9. Readerless doors:
  1. The ACS shall support doors configured solely with a lock, a REX and a door contact, but without readers.
  2. The implementation of a readerless door shall be possible with the use of standard access hardware IO modules. External hardware such as timers shall not be required.
  3. Unlocking schedules shall be programmable for readerless doors.
  4. Standard door activity reports shall also be possible with readerless doors.
10. Unlocking schedules and exceptions to unlocking schedules shall be associated with a door. An unlocking schedule shall determine when a door should be automatically unlocked. The ACS shall also support the use of a specific offline unlocking schedule. Exceptions to unlocking schedules shall be used to define time periods during which unlocking schedules shall not be applied, such as during statutory holidays.

11. The ACS shall support Anti-passback to prevent the same cardholder credentials from gaining entry into the same controlled area.
12. The ACS shall support grouping of doors to which anti-passback rules can be applied. It shall be possible to designate parent regions for hierarchical anti-passback.

#### **2.18 ACS ELEVATOR MANAGEMENT**

1. The ACS shall support the configuration and management of CR in the elevators. A user shall be able to add, delete, or modify an elevator if he or she has the appropriate privileges.
2. The ACS shall be able to control access to specific floors using a reader within the elevator cab. Control shall be available through the use of a controller with an interface to a reader and to multiple output modules with relays.
3. Elevator floor selections shall be tracked using a controller with an interface to multiple input modules. Floor tracking shall be available within an elevator activity report.
4. The elevator control module shall continue to function in offline mode, should communication between the ACS and the control module fail.

#### **2.19 ACS GLOBAL CARDHOLDER MANAGEMENT**

1. The ACS shall support global cardholder management and synchronization between a central independent site and remote independent sites, all of which can have their own databases and/or portion the central database.
2. It shall be possible to synchronize the following entities and their configuration data:
  1. Cardholders (including custom fields).
  2. Cardholder groups.
  3. Credentials.
  4. Badge templates.
3. Cardholders and other synchronized entities can be added centrally and synchronized to remote sites for central cardholder management. Changes in cardholder access rights will be universally applied across the central and synchronized remote sites.
4. Cardholders and other synchronized entities can be added at remote sites and synchronized to the central site and other remote sites. Changes in cardholder access rights will be universally applied across the central and all other synchronized remote sites.
5. The ACS shall support the assignment of a single card per cardholder across all of an organization's sites.
6. Manual and scheduled synchronization shall be supported.

#### **2.20 ACS CARDHOLDER AND CARDHOLDER GROUP MANAGEMENT**

1. The ACS shall support the configuration and management of cardholders and cardholder groups. A user shall be able to add, delete, or modify a cardholder or cardholder group if he or she has the appropriate privileges.
2. User Defined Fields shall be supported.
3. The ACS shall permit the following activation/expiration options for a cardholder's profile: delayed activation of a cardholder's profile, expiration based on the date of first use of credentials, or expiration on a user-defined date.
4. It shall be possible to associate a picture to a cardholder's profile. The picture shall be imported from a file, captured with a digital camera, or captured from a video surveillance camera. When a cardholder event occurs, the ACS shall have the option to have the picture of the cardholder to be displayed in the UI. The ACS shall support multiple standard picture formats.

5. Cardholder groups shall enable the grouping of cardholders to facilitate mass changes to system settings. It shall be possible to assign cardholder groups to access rules, thus avoiding the assignment of one cardholder at a time.
6. It shall be possible to search by picture association, custom user-defined fields, names and credential codes.
7. It shall be possible to select multiple cardholders for immediate deactivation or reactivation.
8. The ACS shall support the synchronization of cardholders and cardholders group through Active Directory including the credentials and pictures of the cardholders.

## **2.21 ACS CREDENTIAL MANAGEMENT**

1. The ACS shall support the configuration and management of credentials, e.g. access cards and keypad PIN numbers. A user shall be able to add, delete, or modify a credential if the user has the appropriate privileges.
2. Users shall be able to add Custom Fields (user-defined fields) to credentials. Creating a new credential shall be accomplished either manually or automatically.
3. Automatic creation shall allow the user to create a credential entity by presenting a credential to a selected reader. The ACS shall read the card data and associate it to the credential entity. It shall be possible to automatically enroll any card format (128 bits or less)
4. The ACS shall support multiple credentials per cardholder without necessitating duplicate cardholder information. The ACS shall automatically detect and prevent attempts to register an already-registered credential.
5. Batch enrollment of credentials shall be supported.
6. The ACS shall provide a workflow for badge issuance, photo ID and card requests.
7. A custom card format feature shall allow the administrator to add additional custom card formats.

## **2.22 BADGE DESIGNER**

1. The badge designer shall allow the creation of badge templates that define the content and presentation format of a cardholder badge to be printed.
2. Batch printing of cards shall be available.
3. Supported badge formats shall be (portrait and landscape).
4. Dual-sided badges shall be supported.
5. A badge template import and export function shall be available to allow the sharing of badge templates between distinct or independent ACS.
6. Printing of Barcodes on badge shall be supported.

## **2.23 PEOPLE/OCCUPANCY COUNTING, AREA PRESENCE TRACKING AND MUSTERING**

1. The ACS shall support people counting (or area presence tracking). The ACS shall be able to monitor and report the number of cardholders in an area in real-time and for all areas. Monitoring shall be based on the entire access control infrastructure, for both local areas and those in remote geographic locations. People counting can also be used to perform mustering.
2. The ACS shall dynamically track and report the total number of cardholders in an area. Displayed data shall be updated dynamically.
3. The ACS shall be able to generate an area presence report listing the cardholders located in one or more areas. It shall be possible to filter the report by area and time period. The report shall also include activity from sub-areas (nested areas).

## 2.24 MICROSOFT ACTIVE DIRECTORY INTEGRATION

1. The ACS shall support a direct connection to a Microsoft Active Directory server. Active Directory integration shall enable the synchronization of information from the Active Directory server to the ACS.
2. Active Directory integration shall permit the central management of the ACS users, user groups, cardholders, and cardholder groups.
3. The ACS shall support using secure LDAP connections to Microsoft Active Directory using SSL encryption.
4. The ACS shall support Active Directory group nesting up to 12 or more levels deep.
5. The ACS shall support Active Directory single sign-On
6. When enabled, Active Directory shall manage user logon to the ACS client applications through the user's Windows credentials. Logging into the ACS shall utilize native Active Directory password management and authentication features.
7. It shall be possible to synchronize the following ACS entities and their information from Active Directory with the ACS:
  1. Users.
  2. User groups membership.
  3. Cardholders.
  4. Cardholder groups membership.
  5. Active Directory attributes to ACS custom user defined fields.
8. When enabled, the addition, removal, or suspension of a user's Windows account in Active Directory shall result in the creation, deletion, or disabling of the equivalent user account in the ACS.
9. When enabled, the addition, removal, or suspension of a user's Windows account in Active Directory shall result in the creation, deletion, or disabling of the equivalent cardholder account in the ACS.
10. Supported synchronization methods for additions, modification, and deletions of synchronized entities shall include on first logon (users only), manual synchronization, and scheduled synchronization.

## 2.25 THREAT LEVEL MANAGEMENT

1. The ACS shall support Threat Level Management to dynamically change the system behavior to respond to critical events.
2. Threat Levels shall be activated and deactivated by the ACS users with the right privilege.
3. It shall be possible for Threat Levels to be set on a door, door grouping, and area or on the entire system.
4. Threat Levels shall affect the system behavior by executing any action available in the ACS such as but not limited to trigger output, start, arm zone, and set door modes. Optimally Threat Levels Management shall also control the converged Video Management system by executing such actions as starting recording, blocking camera, overriding recording quality.
5. The following specific actions shall be available with Threat Level:
  1. Set minimum security clearance to restrict or permit access to cardholders on specific areas on top of the restrictions imposed by the access rules.
  2. Set reader mode to change how the doors are accessed (e.g. card and PIN, or card or PIN).
  3. At least 3 Threat levels shall be definable per geographic system location.
  4. Initiation of a communication workflow to notify all applicable stakeholder of the Threat level condition.

5. Ideally, the application will permit the running of a threat level simulation.
6. Ideally, the application will permit anti-passback rules to be applied against door, groups of doors or areas.
7. Execution of a Threat level activation shall involve Zero risk to personnel responsible for initiating the activation.
8. Activating a Threat level shall be possible from an application operating on any computing device, (desktop computer, laptop, tablet, and smart phone), running Windows, Unix/Linux, Google OS, android, iOS, or MAC OS.

## **2.26 ACS SYSTEM ARCHITECTURE**

1. The ACS shall have a distributed architecture, with every geographic location functioning as its own individual system, with no reduction in administrative functionality; all system will be united in a manner to function as one concise system.
2. Each geographically located ACS system shall support following access control and administrative functionalities, without the aid of or connectivity to an upstream ACS:
  1. Connect to an Active Directory Domain Controller Server.
  2. Support cardholder management and user logon management through Active Directory.
  3. Support Active Directory group nesting.
  4. Allow monitoring and control of the ACS through a web browser interface.
  5. Be compatible with virtual environments.
  6. Provide the ability to run reports on important software and hardware events.
  7. Provide the ability for end users to visualize their security environment through mapping functionality.
  8. Support an unrestricted number of logs and historical transactions, with the maximum allowable size being limited only by the amount of hard disk space.
3. ACS shall be capable of linking at least 150 geographically dispersed autonomous ACS systems into one large ACS system. The large ACS system shall be capable of:
  1. Support global alarm management.
  2. Support global report generation.

## **2.27 WEB CLIENT (WC) GENERAL REQUIREMENTS**

1. The ACS shall support a WC for typical access control system management.
2. The WC shall be a truly thin client with no download required other than an internet web browser or standard web browser plugins.
3. The WC shall be platform independent and run within Microsoft Internet Explorer, Firefox, Safari, and Google Chrome.
4. Web pages for the web client shall be managed and pushed by the ACS software offering. Microsoft IIS, Apache or any other web hosting service shall not be required.
5. Functionalities:
  1. Login using name and password or Active Directory support shall be available.
  2. Encrypted communications for all transactions.
  3. Print reports and export.
  4. Access Control:
    1. Cardholder and group (add/modify/delete).
    2. Credential management (modify/delete).
    3. Unlock door.
    4. Door Activities report.
    5. Initiate Threat Level Management.
  5. Alarms:

1. Alarm report.

## **2.28 LOGGING AND AUDITING**

1. The ACS shall receive and log the following events:
  1. System-wide events.
  2. Application events (clients and servers).
  3. Area, door and elevator.
  4. Remote Unit events.
  5. Zone events.
2. Alarm events.
3. The ACS shall support the generation of audit trails. Audit trails shall consist of logs of operator/administrator additions, deletions, and modifications.
4. Audit trails shall be generated as reports. They shall be able to track changes made within specific time periods. Querying on specific users, changes, affected entities, and time periods shall also be possible.
5. For entity configuration changes, the audit trail report shall include detailed information of the value before and after the changes.
6. The ACS shall support the generation of user activity trails. User activity trails shall consist of logs of operator activity on the ACS such as login, camera viewed, badge printing, video export, and more.
7. The ACS shall support the following actions on an audit and activity trail report: print report and export report to a PDF/Microsoft Excel/CSV file.

## **2.29 ACS SOFTWARE REPORTING**

1. The ACS shall support report generation (database reporting) for access control.
2. Each and every report in the system shall be a SOFTWARE task, each associated with its own privilege. A user shall have access to a specific report task if he or she has the appropriate privilege.
3. The workflows to create, modify, and run a report shall be consistent for access control and the unified video reports.
4. Reports shall allow global consolidated reporting across multiple independent geographically located ACS and unified VMS systems.
5. Reports shall support cardholder pictures.
6. The ACS software shall support the following types of reports:
  1. Alarm reports.
  2. Configuration reports (cardholders, credentials, units, access rules, readers/inputs/outputs, and more).
  3. Activity reports (cardholder, cardholder group, visitor, credential, door, unit, area, zone, elevator, and more).
  4. Health activity and health statistics reports.
  5. Other types of reports, including visitor reports, audit trail reports, incident reports, and time and attendance reports.
7. Generic Reports, Custom Reports and Report Templates:
  1. The user shall have the option of generating generic reports from an existing list, generating reports from a list of user-defined templates, or creating a new report or report template.



2. The user shall be able to customize the predefined reports and save them as new report templates. There shall be no need for an external reporting tool to create custom reports and report templates. Customization options shall include setting filters, report lengths, and timeout period. The user shall also be able to set which columns shall be visible in a report. The sorting of reported data shall be available (ascending or descending).
3. All report templates shall be created within the UI.
4. These templates can be used to generate reports on a schedule in PDF or Excel formats.
5. An unrestricted number of custom reports and templates shall be supported.
8. The ACS software shall support comprehensive data filtering for most reports based on entity type, event type, event timestamp, custom fields and more.
9. The SOFTWARE shall support the following actions on a report: print report, export report to a PDF/Microsoft Excel/CSV file, and automatically email a report based on a schedule and a list of one or more recipients.

### **2.30 SOFTWARE DYNAMIC GRAPHICAL MAPS (DGM)**

1. The SOFTWARE shall support mapping functionality for access control, unified video surveillance and external applications.
2. The SOFTWARE shall provide a map centric interface with the ability to command and control all the ACS capabilities from a full screen map interface.
3. The DGM shall offer a user-friendly graphical map designer to configure the maps.
4. The DGM shall provide a user friendly and intuitive navigation that includes:
  1. The ability to create hierarchies of maps to facilitate navigation within and between various sites and buildings.
  2. The possibility to create links between maps. The map links shall allow the link from one map to multiple maps representing the floors of a building.
5. It shall be possible to monitor the state of entities on the map. It shall be possible to customize the icons of any entities represented on the map.
6. It shall be possible to access live and playback video from the map.
7. It shall be possible to monitor from the map all entities event notifications. Users shall be able to turn notifications on and off per entity.
8. The DGM shall provide an intuitive built-in map designer for entity positioning on the map using drag and drop. Any configuration shall be graphic.

### **2.31 ACS IMPORT TOOL**

1. The ACS shall support an integrated Import Tool to facilitate the import of existing cardholder and credential data. The import of data shall be through the use the CSV file format.
2. The Import Tool shall also support the functionality to manually import data that has been exported from a third-party database if it is in CSV format.
3. The import tool shall permit the import of the following data:
  1. Cardholder name, descriptions, picture, email, and status.
  2. Cardholder group information.
  3. Credential name, status, format, and card number (including credentials with custom formats).
  4. Custom fields.
4. Full flexibility in selecting the fields to be imported during an import session shall be available.
5. The ACS shall also support re-importing a CSV file containing new information to update existing information in the ACS database. Re-importing shall enable bulk amendments to existing access control data

### **3 Execution**

#### **3.1 INSTALLATION**

1. The Security Contractor shall install all system components and appurtenances in accordance with the Manufacturer's instructions, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Provide mounting hardware as required. The security contractor shall coordinate with the general contractor on all installations and schedule to ensure timely completion of the project.
2. All low voltage wiring outside the control console, cabinets, boxes, and similar enclosures, shall be plenum rated where required by code. Cable shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.
3. All inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors and as shown. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fiber optics, which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.

#### **3.2 SITE VISITS**

1. The Security Contractor will coordinate with the General Contractor for all construction and installation schedules. The Security Contractor should make a minimum of 2 site visits prior to commencing installation.

#### **3.3 TESTING**

1. The Security Contractor shall perform pre-delivery testing, site testing, and adjustment of the completed Integrated Intrusion & Access Control System. The contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the Owner at least two (2) business days prior to the test and in no case shall notice be given until after the contractor has received written approval of the specific test procedures. Test procedures shall explain in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. Test reports shall be used to document results of the tests. Reports shall be delivered to the owner within seven (7) days after completion of each test.
2. The contractor shall demonstrate that the completed Integrated Intrusion & Access Control System complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown.

#### **3.4 FIELD QUALITY CONTROL**

1. Manufacturer's Field Services:
  1. Obtain written reports from Manufacturer verifying compliance of work, in handling, installing, applying, protecting and cleaning of product.
  2. Submit 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. Ensure Manufacturer's representative is present before and during critical periods of installation, testing.
  4. Schedule site visits to review work at stages listed:
    1. After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.

2. Upon completion of work, after cleaning is carried out.

### **3.5 ADJUSTING**

1. Set up and adjust all ACS components for correct function.

### **3.6 TRAINING AND MAINTENANCE**

1. The contractor shall provide a minimum of 12 hours in three different sessions within three months for instructing the Owner's maintenance and security personnel in the operation of the system.
2. The contractor shall be responsible in maintaining the equipment in good working order for a period of at least one year from Substantial Performance without compensation. Transfer any extended warranty available from manufacturer to the Owner without extra charge.

**END OF SECTION**

## 1 General

### 1.1 RELATED REQUIREMENTS

1. Division 26 – Electrical:
  1. Section 26 05 34 – Conduits, Conduit Fastenings, and Conduit Fittings.
2. Division 27 – Communications:
  1. Section 27 05 26 – Grounding and Bonding for Communications Systems.
  2. Section 27 05 28 – Pathways for Communications Systems.
3. Division 28 – Electronic Safety and Security:
  1. Section 28 13 00 – Access Control System.
  2. Section 28 31 00 – Intrusion Alarm System.

### 1.2 REFERENCE STANDARDS

1. The equipment, materials and installation for the Closed-Circuit Television (CCTV) Video Surveillance System shall comply and conform to the latest version of the following applicable codes, standards (including technical service bulletins and Addenda), guidelines, reference handbooks, and regulations of authorities having jurisdiction (AHJ)

CSA C22.1 1-2018, 24 <sup>th</sup> Ed.	Canadian Electrical Code, Part I
OESC 2015, 26 <sup>th</sup> Ed.	Ontario Electrical Safety Code
OBC 2015 Ed.	Ontario Building Code
ITSG-11A	COMSEC Installation Planning – Guidance and Criteria
ANSI/TIA-568.0-D	Generic Telecommunications Cabling for Customer Premises
ANSI/TIA-568.1-D	Commercial Building Telecommunications Cabling Standard
ANSI/TIA-569-D	Telecommunications Pathways and Spaces
ANSI/TIA-606-C	Administration Standard for Telecommunications Infrastructure
ANSI/TIA-607-C	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

### 1.3 DEFINITIONS

1. “CCTV” shall mean Closed Circuit Television. The CCTV includes (but not limited to) the 4K/POE/IP-based Cameras, Video Management System (VMS), CCTV Server, CCTV Monitor, CCTV Software Licenses, Cat6 Structured Cabling System (SCS), Security Conduit System, Pull Boxes, System Programming Manual, System Operation Manual, and Training Manual.
2. “IAS” shall mean Intrusion Alarm System. It includes (but not limited to) the IAS Main Control Panel (with 8-board zones), IAS Server, IAS Monitor, IAS Software Licenses, Control Cabinet, Lock-keys, Power Supplies, Batteries, Motion Detectors, Glass break Detectors, Security Wiring System, Security Conduit System, System Programming Manual, System Operation Manual, and Training Manual.
3. “ACS” shall mean Access Control System. It includes (but not limited to) the ACS Panel with Door Controllers, ACS Server, ACS Monitor, ACS Software Licenses, Power Supplies, Batteries, Door Contacts (DC), Card Readers (CR), Keypad (KP), Electric Strikes (ES), Request-to-Exit (REX) with Motion Detectors, Request-to-Exit Switch (RX), Security Wiring, Security Conduit System, System Programming Manual, System Operation Manual, and Training Manual.
4. “SBB” shall mean Secondary Bonding Busbar. There is typically one SBB per Main Equipment Room (MER), and Telecom Room (TR). The SBB is connected both to the Primary Bonding Busbar (PBB) and to building structural steel or other permanent metallic systems.
5. “N.I.C” shall mean Not in Contract.

#### 1.4 SCOPE OF WORK

1. The Security Contractor is to provide a complete CCTV system consisting of IP-based Cameras, CCTV Software Licenses, Cat 6A cables, media converter, fiber optic cable, conduits, pull boxes, and all devices required to make a complete and operative CCTV system as described herein.
2. The Electrical Contractor (Division 26) shall provide all security conduit system for the CCTV. For conduit details, refer to the Section 26 05 34 and 27 05 28 Specifications.

#### 1.5 QUALITY ASSURANCE - CERTIFICATION

1. Manufacturer Qualification:
  1. The CCTV system manufacturer shall have been in business manufacturing similar products for at least 5 years.
  2. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standards.
2. Installer Qualification:
  1. The Security Contractor shall be registered as a Certified Security Installer for the installation and maintenance of the CCTV system from the acceptable security Manufacturer(s). The Security Contractor shall have at least five years of experience installing CCTV, ACS, and IAS systems.
  2. All CCTV products are to be by a single Manufacturer unless otherwise stated in this document.
  3. The Security Contractor selected for this project must provide a Manufacturer's Certification Number to confirm training received from the manufacturer (s) prior to start of work.
  4. The Security Contractor shall engage manufacturer for commissioning and certifying of manufacturers' equipment hardware and software two weeks prior to substantial completion of work.
  5. The Security Contractor shall be factory-trained and certified to maintain/repair the system after system acceptance.

#### 1.6 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data:
    1. Submit manufacturer's instructions, and data sheets for the CCTV cameras, and required accessory devices including product features, performance criteria, physical size, finish and limitations.
    2. Submit the following documents:
      1. Functional description of equipment.
      2. Technical datasheets for all CCTV devices.
      3. Devices mounting location detail drawings.
      4. Typical devices connection detail drawings.
  2. Shop Drawings:
    1. Shop drawings to indicate CCTV layouts, mounting height and location of the keypad on drawings, detail wiring diagrams, etc.
    2. Complete wiring diagram, including riser diagram.
    3. Complete description of the system operation.
    4. Complete description of each component and module.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

### **1.7 DELIVERY, STORAGE, AND HANDLING**

1. The Security Contractor shall be responsible for the storage and handling of all materials required by the CCTV for this project.
2. Storage and Protection: Any materials that show signs of mishandling or have been stored in a fashion so as to reduce the value of the materials shall be replaced with new materials at no additional cost to the Owner.
3. Protect store materials from environmental and temperature conditions following manufacturer's instructions. Handle and operate products and systems according to manufacturer's instructions.
4. Deliver materials in manufacturer's original, unopened, undamaged containers, and unharmed original identification labels.
5. Waste management and disposal procedures.

### **1.8 PROJECT CONDITIONS**

1. During the CCTV installation, testing, and commissioning process; the Security Contractor shall maintain the environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

### **1.9 CLOSEOUT SUBMITTALS**

1. Operation and Maintenance (O&M) Data: Submit maintenance data for incorporation into the O&M manual.
  1. Include:
    1. CCTV system configuration and equipment physical layouts.
    2. CCTV functional description of equipment.
    3. Instructions for the O&M of equipment.
    4. Illustrations and diagrams to O&M supplement procedures.
    5. O&M instructions provided by manufacturer.
  2. Manufacturer's Instructions: Submit manufacturer's installation instruction manuals.
  3. Manufacturer's Field Reports: Submit manufacturer's written reports within five (5) days of review, verifying compliance of work.
  4. As-built Records and Drawings.

### **1.10 WARRANTY**

1. All components, parts, and assemblies supplied by the manufacturers and installed by the Security Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.
2. Service/Maintenance:
  1. System maintenance and repair of the CCTV system or workmanship defects during the warranty period shall be provided by the Security Contractor free of charge (parts and labor)
  2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
  3. The Security installer shall correct any system defect within six hours of receipt of call from the Owner.
  4. Extended service/maintenance agreements shall be offered by the Security Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

### 1.11 PREFERRED MANUFACTURERS

1. The CCTV products/materials are to be equal, or equivalent, or similar to the following manufacturer list, below.

Products/Materials	Approved Manufacturer
CCTV IP-based Cameras	AXIS Communications, or equivalent approved by Owner.

## 2 Products

### 2.1 MATERIALS

1. Provide all system materials/components and equipment required to make a complete and operational system as indicated.

### 2.2 CCTV CAMERAS

1. Outdoor 180° Panoramic Camera:

1. Camera:

1. Image Sensor: 3 x 5MP 1/ 2.8" scan RGB CMOS.
2. Lens:
  1. Fixed 3.2mm, F2.0
  2. Horizontal field of view: 180°
  3. Vertical field of view: 90°

2. Video:

1. Video compression: H.264, H.265, Motion JPEG
2. Resolution: 5120 x 2560 (13.1MP)
3. Frame rate: 13.1MP @ 25/30 fps

3. Audio:

1. Audio streaming: Two-way audio via edge-to-edge technology

4. Network:

1. Security: IP address filtering, HTTPS encryption, IEEE 802.1x
2. Network protocols: IPv4, IPv6, HTTP, HTTPS

5. System integration:

1. Open API, ONVIF

6. Analytics:

1. Fence guard, motion guard, loitering guard, video motion detection, active tampering alarm, audio detection

7. Power:

1. Power over Ethernet (PoE) IEEE 802.3at Type 2 Class 4
2. Typical 11W, max 18W

8. Connectors:

1. Shielded RJ45 1000BASE-T

9. General:

1. Operating temperature: -40°C to 50°C.
2. IP rating: IP66/IP67, NEMA 4X rated, IK10 rated.

10. Product model:

1. AXIS P3818-PVE Panoramic Camera,

2. or equivalent approved by the Owner.
2. Outdoor 5MP Dome Camera:
  1. Camera:
    1. Image Sensor: 1/ 2.7" progressive scan RGB CMOS.
    2. Lens:
      1. Varifocal, 3~8mm, F1.3
      2. Horizontal field of view: 104° ~ 40°
      3. Vertical field of view: 74° ~ 29°
  2. Video:
    1. Video compression: H.264, H.265, Motion JPEG
    2. Resolution: 2592 x 1944 (5MP)
    3. Frame rate: 5MP @ 25/30 fps
  3. Audio:
    1. Audio streaming: Two-way audio
  4. Network:
    1. Security: IEEE 802.1X, IEEE 802.1AE, IEEE 802.1AR
    2. Network protocols: IPv4, IPv6, HTTP, HTTPS
  5. System integration:
    1. Open API, ONVIF
  6. Analytics:
    1. Fence guard, motion guard, loitering guard, video motion detection, active tampering alarm, audio detection
  7. Power:
    1. Power over Ethernet (PoE) IEEE 802.3af/802.3at Type 1 Class 3
    2. Typical 6.4W, max 12.1W
  8. Connectors:
    1. RJ45 10BASE-T/100BASE-TX PoE
  9. General:
    1. Operating temperature: -40°C to 50°C.
    2. IP rating: IP66, NEMA 4X rated, IK10 rated.
  10. Product model:
    1. AXIS P3267-LVE Dome Camera,
    2. or equivalent approved by the Owner.
3. Indoor 4MP Dome Camera:
  1. Camera:
    1. Image Sensor: 1/ 2.7" progressive scan RGB CMOS.
    2. Lens:
      1. Varifocal, 3~6mm, F1.9 ~2.7
      2. Horizontal field of view: 100° ~ 45°
      3. Vertical field of view: 72° ~ 34°
  2. Video:
    1. Video compression: H.264, H.265, Motion JPEG
    2. Resolution: 2304 x 1728 (4MP)



3. Frame rate: 4MP @ 25/30 fps
3. Audio:
  1. Audio streaming: Two-way audio
4. Network:
  1. Security: IEEE 802.1X, IEEE 802.1AE, IEEE 802.1AR
  2. Network protocols: IPv4, IPv6, HTTP, HTTPS
5. System integration:
  1. Open API, ONVIF
6. Analytics:
  1. Fence guard, motion guard, loitering guard, video motion detection, active tampering alarm, audio detection
7. Power:
  1. Power over Ethernet (PoE) IEEE 802.3af/802.3at Type 1 Class 3
  2. Typical 5W, max 9.7W
8. Connectors:
  1. RJ45 10BASE-T/100BASE-TX PoE
9. General:
  1. Operating temperature: 0°C to 45°C.
  2. IP rating: IP42 water and dust resistant, IK08 rated.
10. Product model:
  1. AXIS M4216-LV Dome Camera,
  2. or equivalent approved by the Owner.

## 2.3 OUTDOOR CCTV ENCLOSURE

1. Outdoor CCTV enclosure shall be provided for the camera where the CCTV camera is more than 90 meters away from IT room. Outdoor CCTV enclosure equipped with NEMA 4X enclosure, media converter, power supply, surge protector, associated accessories and termination of fiber optical cable. The outdoor CCTV enclosure will be mounted on the pole where camera installed as indicated on the drawings. The outdoor CCTV enclosure will include the following:
2. Outdoor NEMA4X enclosure:
  1. Outdoor NEMA4X/IP66 rated.
  2. Material: Stainless Steel.
  3. Minimum Dimension: 400mm (Height) x 300mm (Width) x 200mm (Depth)
  4. Equipped with back panel, DIN-rail, power receptacle, lock and grounding busbar.
3. Media Converter:
  1. Standards:
    1. IEEE 802.3af, IEEE 802.3at, IEEE 802.3bt.
  2. Device Interface
    1. 2 x Gigabit SFP ports.
    2. 2 x Gigabit PoE++ ports.
    3. 4-pin removable terminal block
    4. LED indicators
    5. DIN-Rail mount
    6. Wall mount

7. Grounding point
  3. Data Transfer Rate:
    1. Gigabit: 2Gbps (full duplex)
    2. SFP: 2Gbps (full duplex)
  4. Power:
    1. Input: 48 ~ 56V DC
    2. Consumption: 3.84W (without PoE) @48V DC
  5. PoE
    1. PoE budget: 90W
  6. General:
    1. Operating Temperature: -40°C to 75°C.
    2. Operating Humidity: Max. 95% non-condensing
    3. Hardened components rated for extreme temperatures.
    4. Auto-Negotiation, Automatic address learning and address aging
    5. IP30 rated metal housing
  7. Product model:
    1. TRENDnet 2-Port Industrial SFP to Gigabit PoE++ Media Converter: TI-BF22SFP
    2. or equivalent approved by the Owner.
4. SFP Module
1. To be installed in media converter to interface with fiber optic cable.
  2. Standards:
    1. IEEE 802.3, IEEE 802.3u, IEEE 802.3z
  3. Device Interface:
    1. SFP MSA Compliant
    2. LC duplex connector
  4. Data Transfer Rate:
    1. 1.25Gbps
  5. Wavelength
    1. 850nm
  6. Optical Output Power
    1. -9 ~ -3 dBm
  7. Distance:
    1. 550m
  8. Sensitivity:
    1. -20 dBm
  9. General:
    1. Operating Temperature: 0°C to 70°C.
    2. Operating Humidity: Max. 85% non-condensing
    3. Hot pluggable
    4. Metal enclosure.
  10. Product model:
    1. TRENDnet SFP Multi-Mode LC Module: TEG-MGBSX

2. or equivalent approved by the Owner.
5. Surge Protector
  1. Provide surge protector, mounted in outdoor NEMA4X enclosure to protect outdoor camera.
  2. Minimum requirement:
    1. Type: Surge protector
    2. Technology: CAT5/5E, CAT6, CAT6A, CAT8
    3. Response Time: < 1 ns
    4. Surface Mount, Metal Case
    5. Number of Ports: One (1) RJ-45 input, one (1) RJ-45 output.
    6. ESD protection: 8k/15kV
    7. EFT protection: 2kV
    8. Lightning Protection: 2kA(8/20us), 6kV (8/20us)
6. Power Supply
  1. Interface:
    1. Input: 90 ~ 264V AC, 47 ~ 63Hz, 1.8A,
    2. Output: 150W, 48 ~ 56V DC, 0~2.9A
  2. Housing
    1. DIN-rail mount
    2. Power LED indicator
  3. Special Features
    1. DC OK relay contact
    2. 150% peak load capacity
    3. Protection functions
      1. Short circuit
      2. Over power
      3. Over voltage
      4. Over current
      5. Over temperature
    4. Protection type: shutdown and self-recovery
  4. General:
    1. Operating Temperature: -25°C to 70°C.
    2. Operating Humidity: Max. 95% non-condensing
  5. Product model:
    1. TRENDnet DIN-rail Power Supply: TI-S15052
    2. or equivalent approved by the Owner.

## **2.4 CCTV CAMERA CABLING**

1. Refer to Section 27 10 05 Structured Cabling for Communication Systems.

## **2.5 CCTV CAMERA VMS, NVR AND LICENSE**

1. The Security Contractor is to confirm with the Owner the approved cameras to be compatible with existing security system before ordering to site.
2. The Security Contractor to provide CCTV cameras licenses as required.
3. The Owner is responsible for incorporating new CCTV cameras into existing security networks and Video Management System (VMS) and providing sufficient Network Video Recording (NVR) capacity to accommodate new cameras.

### **3 Execution**

#### **3.1 INSTALLATION**

1. Install the CCTV system, including the Cat6A cables, CCTV cameras, pull boxes, conduits, and miscellaneous positioning material to constitute a complete system. Coordinate with other disciplines.
2. All conduit system shall be installed by Division 26. For conduit details, refer to the Section 26 05 34 and 27 05 28 Specifications.
3. Conduits shall not have more than 3-90 deg. or equivalent bends in each run, with the bending radii not less than 10 times the conduit dia. Pull boxes shall be provided in each conduit run at intervals of not more than 100' (30 m).
4. All conduits shall be run above suspended ceiling or concealed in walls and shall be co-ordinated with other services.
5. Provide all wires and cable and leave adequate loose cable in the device boxes and termination boxes for cable termination.
6. Confirm exact locations of all components prior to roughing in.

#### **3.2 TESTS**

1. System testing and commissioning shall be carried out by qualified personnel of the manufacturer.
2. Upon system completion and verification, conduct a witness inspection for the manufacturer to demonstrate the system operation to the Owner's representative.
3. The system supplier will conduct a system testing and inspection upon completion of the installation. The installation shall comprise of the following:
  1. To verify that equipment installed is that designated by this Specification.
  2. To verify the operation of the entire system is as specified.
  3. To verify that the installation of the system is in accordance with the manufacturer's instructions and in accordance with all applicable Codes of governing bodies having jurisdiction.
  4. An acceptance test in the presence of and to the satisfaction of the Project Manager.
  5. Providing a copy of the inspecting technician's report showing location of each device and certifying the test results of each device shall be forwarded to the Construction Manager.

#### **3.3 TRAINING AND MAINTENANCE**

1. The contractor shall provide a minimum of 12 hours in three different sessions within three months for instructing the Owner's maintenance and security personnel in the operation of the system.
2. The contractor shall be responsible in maintaining the equipment in good working order for a period of at least one year from Substantial Performance without compensation. Transfer any extended warranty available from manufacturer to the Owner without extra charge.

**END OF SECTION**

## 1 General

### 1.1 RELATED REQUIREMENTS

1. Division 26 – Electrical:
  1. Section 26 05 34 – Conduits, Conduit Fastenings, and Conduit Fittings.
2. Division 27 – Communications:
  1. Section 27 05 26 – Grounding and Bonding for Communications Systems.
  2. Section 27 05 28 – Pathways for Communications Systems.
3. Division 28 – Electronic Safety and Security:
  1. Section 28 13 00 – Access Control Systems
  2. Section 28 23 00 – CCTV Video Surveillance

### 1.2 REFERENCE STANDARDS

1. The equipment, materials and installation for the Intrusion Alarm System (IAS) shall comply and conform to the latest version of the following applicable codes, standards (including technical service bulletins and Addenda), guidelines, reference handbooks, and regulations of authorities having jurisdiction (AHJ)

CSA C22.1 1-2018, 24 <sup>th</sup> Ed.	Canadian Electrical Code, Part I
OESC 2015, 26 <sup>th</sup> Ed.	Ontario Electrical Safety Code
OBC 2015 Ed.	Ontario Building Code
ITSG-11A	COMSEC Installation Planning – Guidance and Criteria
OFC-2015	Ontario Fire Code for Commercial Applications
ANSI/TIA-968-B-2016	Technical Requirements for Connection of Terminal Equipment to the Telephone Network
IEEE/ANSI C63.4 / IEEE/ANSI C63.10	Wireless Devices and Radio Noise Emissions Package
CAN/ULC-S304:2016	Standard for Control Units, Accessories and Receiving Equipment for Intrusion Alarm System
CAN/ULC-S302-14	Standard for the installation, inspection and Testing of intrusion Alarm Systems
CAN/ULC-S306-03	Intrusion Detection Units
CAN/ULC-S318-96 (R2016)	Standard for Power Supplies for Burglar Alarm Systems
CAN/ULC-S545-02	Standard for Residential Fire Warning System Control
ULC-ORD-C604 (R2016)	Connectors and Switches for use with Burglar Alarm Systems
ULC-ORD-C1023-74	Household Burglar Alarm System Units
ULC-ORD-C1076	Proprietary Burglar Alarm Units and System
ICES-003-2014	Information Technology Equipment (ITE) — Limits and Methods of Measurement for Discussion — Data Breach Notification and Reporting Regulations
UL 50	Enclosures for Electrical Equipment
UL 294	Access Control System Units
UL 365	Police Station Connected Burglar Alarm Units and Systems
UL 603	Standard for Power Supplies for Use with Burglar-Alarm Systems
UL 609	Local Burglar Alarm Units and Systems
UL 864	Control Units and Accessories for fire Alarm Systems (Commercial Fire)
UL 985	Household Fire Warning System Units
UL 1023	Household Burglar Alarm System Units

UL 1076	Proprietary Burglar Alarm Units and Systems
UL 1610	Central Station Burglar-Alarm Units
UL 60950-1	Information Technology Equipment - Safety
UL 636	Hold up alarms

Important: All CAN/ULC standards are applied to equipment/products, materials and installation methods. They are not applied to specific company name, brand name, or trade name.

### 1.3 DEFINITIONS

1. "IAS" shall mean Intrusion Detection System. It includes (but not limited to) the IAS Main Control Panel (with 8-board zones), IAS Server, IAS Monitor, IAS Software Licenses, Control Cabinet, Lock-keys, Power Supplies, Batteries, Motion Detectors, Glass break Detectors, Security Wiring System, Security Conduit System, System Programming Manual, System Operation Manual, and Training Manual.
2. "ACS" shall mean Access Control System. It includes (but not limited to) the ACS Panel with Door Controllers, ACS Server, ACS Monitor, ACS Software Licenses, Power Supplies, Batteries, Door Contacts (DC), Card Readers (CR), Keypad (KP), Electric Strikes (ES), Request-to-Exit (REX) with Motion Detectors, Request-to-Exit Switch (RX), Security Wiring, Security Conduit System, System Programming Manual, System Operation Manual, and Training Manual.
3. "CCTV" shall mean IP Closed Circuit Television. The CCTV includes (but not limited to) the 4K/PoE/IP-based Cameras, Video Management System (VMS), CCTV Server, CCTV Monitor, CCTV Software Licenses, Cat6 Structured Cabling System (SCS), Security Conduit System, Pull Boxes, System Programming Manual, System Operation Manual, and Training Manual.
4. "SBB" shall mean Secondary Bonding Busbar. There is typically one SBB per Main Equipment Room (MER), and Telecom Room (TR). The SBB is connected both to the Primary Bonding Busbar (PBB) and to building structural steel or other permanent metallic systems.
5. "N.I.C" shall mean Not in Contract.

### 1.4 SYSTEM DESCRIPTION – SCOPE OF WORK

1. the Security Contractor is to provide a functionally complete Intrusion Alarm System (IAS) consisting of the following equipment hardware, software, programing, and all accessories to make a complete and operative IAS described herein.
2. Provide all IAS required hardware such as IAS server, IAS monitor, touchscreen keypads, zone expansion modules IAS panels, batteries (12V, 7A), transformers (16V, 40VA), and IAS security devices (MD, GD, DC) as required.
3. Provide separated door contacts for the IAS and ACS systems.
4. All Keypad devices are to be connected with the IAS panels through 4-conductor, shielded, CMR (e.g. Belden PN: 5502FE or equivalent) as it is within 1000' (305 m) of the IAS panel.
5. The IAS system shall be able to arm/disarm zones/partitions via automated schedules and zone keypads.
6. Provide the IAS Server and Management System Administrator Software (MSAS) Suite including the Configuration Software, Routine System Management (RMS) for remote diagnostics, inspections/maintenance, and Web-based System Administrator Software for professional end-user system administration.
7. The IAS shall be able to accommodate test, diagnostics, and configuration programming functions locally or remotely via a portable programmer or a computer running the IAS MSAS.
8. The IAS shall annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English, and French-Canadian texts.

9. The Security Contractor shall be responsible for identifying requirements for permits from the local Police Department for the installation of the alarm system specified herein and shall assist the Owner in obtaining the relevant alarm permits.
10. The Electrical Contractor (Division 26) shall provide all end-to-end security conduit system for the IAS. For conduit details, refer to the Section 26 05 34 and 27 05 28 Specifications.
11. The IAS shall be programed to provide required partitions in various areas as per the Owner requirements.

## 1.5 QUALITY ASSURANCE - CERTIFICATION

1. Manufacturer Qualification:
  1. The IAS system manufacturer shall have been in business manufacturing similar products for at least 5 years.
  2. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standards.
2. Installer Qualification:
  1. The Security Contractor shall be registered as a Certified Security Installer for the installation and maintenance of the IAS system from the preferred/selected security Manufacturer(s). The Security Contractor shall have at least five years of experience installing IAS, ACS, and CCTV systems.
  2. All IAS products are to be by a preferred/selected Manufacturer unless otherwise stated in this document.
  3. The Security Contractor selected for this project must provide a Manufacturer's Certification Number to confirm training received from the manufacturer (s) prior to start of work.
  4. The Security Contractor shall engage manufacturer for commissioning and certifying of manufacturers' equipment hardware and software two weeks prior to substantial completion of work.
  5. The Security Contractor shall be factory-trained and certified to maintain/repair the system after system acceptance.

## 1.6 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:
  1. Product Data:
    1. Submit manufacturer's instructions, and data sheets for the MSAS, security control panels, keypads, control cabinets/enclosures, power supplies, low-voltage transformers, batteries, IAS security devices (TSKP, MD, GD, etc.) security cables, and detection accessory devices including product features, performance criteria, physical size, finish and limitations.
    2. Submit the following documents:
      1. Functional description of equipment.
      2. Technical datasheets for all security devices.
      3. Device location plans including zone records and partitions.
      4. Security wiring/cabling schedule lists.
      5. Devices mounting location detail drawings.
      6. Typical devices connection detail drawings.
  2. Shop Drawings:
    1. Shop drawings to indicate security device location, mounting height and location of the keypad on drawings, detail wiring diagrams, etc.
    2. Submit zone layout drawings indicating numbers, locations of zones and areas covered.

3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

1. The Security Contractor shall be responsible for the storage and handling of all materials required by the IAS.
2. Storage and Protection: Any materials that show signs of mishandling or have been stored in a fashion so as to reduce the value of the materials shall be replaced with new materials at no additional cost to the Owner.
3. Protect store materials from environmental and temperature conditions following manufacturer's instructions. Handle and operate products and systems according to manufacturer's instructions.
4. Deliver materials in manufacturer's original, unopened, undamaged containers, and unharmed original identification labels.
5. Waste management and disposal procedures.

#### **1.8 CLOSEOUT SUBMITTALS**

1. Operation and Maintenance (O&M) Data: Submit maintenance data for incorporation into the O&M manual.
  1. Include:
    1. IAS system configuration and equipment physical layouts.
    2. IAS functional description of equipment.
    3. Instructions for the O&M of equipment.
    4. Illustrations and diagrams to O&M supplement procedures.
    5. O&M instructions provided by manufacturer.
2. Manufacturer's Instructions: Submit manufacturer's installation instruction manuals.
3. Manufacturer's Field Reports: Submit manufacturer's written reports within 5 days of review, verifying compliance of work.
4. As-built Records and Drawings:

#### **1.9 SITE CONDITIONS**

1. During the IAS installation, testing, and commissioning process; the Security Contractor shall maintain the environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### **1.10 WARRANTY**

1. All components, parts, and assemblies supplied by the manufacturers and installed by the Security Contractor shall be warranted against defects in material and workmanship for a period of at least 12 months (parts and labor), commencing upon date of acceptance by Owner. A qualified factory-trained service representative shall provide warranty service.
2. Service/Maintenance:
  1. System maintenance and repair of the IAS system or workmanship defects during the warranty period shall be provided by the Security Contractor free of charge (parts and labor)
  2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
  3. The Security installer shall correct any system defect within six hours of receipt of call from the Owner.



4. Extended service/maintenance agreements shall be offered by the Security Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

#### 1.11 PREFERRED MANUFACTURERS

1. The IAS products/materials are to be equal, or equivalent, or similar to the following preferred manufacturers list, below.

Products/Materials	Preferred Manufacturers
Control Panels	DSC (Johnson Controls)
Touch Screen Security Interface Keypad	DSC (Johnson Controls)
Power Supplies	Altronix
Cabinets/Enclosures	DSC, Altronix
Motion Detectors	Bosch
IAS Servers and Workstations	Dell, HP
Accessories (Door Contacts, Tamper Switches/Detectors)	GE Security

## 2 Products

### 2.1 MATERIALS

1. Manufacturer:
  1. All IAS products are to be by a preferred/selected Manufacturer unless otherwise stated in this document
2. Material and equipment: The IAS will have the following components.

Item	Description	Type	Notes
1	Control Panels	IAS Main Controller	Quantities as indicated on drawings.
2	Power Supply Modules	Power Supply	Quantities as required.
3	Transformer (16V, 40VA)	Power Supply	Quantities as required.
4	Batteries (12V, 7A)	Battery	Quantities as required.
5	TouchScreen Security Interface Keypad (TSKP)	Keypad	Quantities as required.
6	Motion Detectors (MD)	Sensor	Quantities as required.
7	Glassbreak Detector	Sensor	Quantities as required.
8	Internet and HSPA Dual-Path Alarm Communicator	IAS Main Controller	Quantities as required.
9	IAS Control Cabinet/Enclosures (12.9" Width x 16" Height x 3.5" Depth)	IAS Main Controller	Quantities as required.
10	Accessories (Door Contact, Tamper Switch / Detector, etc.)	Various	Quantities as required.

3. IAS Design Criteria:
  1. The IAS shall use only ULC/UL and CSA certified listed products.
  2. The IAS shall use a company specializing in IAS systems.
  3. The IAS as a modular access control, alarm monitoring system expandable, and easily modified for inputs, outputs and remote expansion modules/stations.
  4. The IAS components are to be in accordance with CAN/ULC-S306 and be capable of:
    1. Annunciating undesirable, abnormal or dangerous condition.
    2. Prioritizing alarms by alarm type, i.e. panic/duress, intrusion and tamper.
    3. Determining zone where alarm occurred.
    4. Annunciating power failure and power restoration.

5. Annunciating low battery condition.
6. Operate continuously for minimum period of 4 hours in the event of a power failure.
5. IAS control panels with continuous tamper detection on door and wall.
  1. Tamper detection to trigger trouble light.
6. Design system with:
  1. Alarm masking.
  2. Remote maintenance or diagnostics with password activation.
  3. Unique identifier for each authorized person.
  4. Arming and disarming capabilities: manual and automatic by time of day, day of week, or by operator command.
  5. Support both manual and automatic responses to alarms entering system.
  6. Each alarm capable of initiating different functions of camera, homing, and activation of remote devices, audio switching, door control and card or pin validation.
  7. Zone or alarm location annunciated at monitoring station.
  8. Communications link: security level of III to CAN/ULC-S304.
  9. Signal link: security level of III to CAN/ULC-S304.
  10. Alarm condition: design system to provide maximum time for an alarm to be communicated of 90 seconds from alarm initiation to annunciation at remote monitoring location.
  11. Junction boxes: All junction boxes inside the secure side have to include tamper switches (continuous tamper-detection capability) with silent alarms and recording events to identify the junction box locations by the IAS & ACS systems.
  12. Design system power supplies rated to provide cumulative load of all systems components plus safety factor of 50% or greater.

## 2.2 CONTROL PANEL:

1. Zones (protection inputs): All exterior doors, entrance doors of IT room as indicated on drawings.
2. Fixed zones per expansion modules: 8.
3. Expandable: 16 - 128 zones.
4. Number of user codes required: 4.
5. Number of areas/partitions: As required.
6. TouchScreen Security Interface Keypad: As required, refer to security layout drawings.
7. Hardwired Keypads: LCD liquid crystal display.
8. Alarm: local, monitored.
9. System: Wire (wireless not required)
10. Integrated with sub systems such as (ACS)
11. Number of programmable outputs required: Refer to riser diagram.
12. System supervision: Mobile communicator (built-in Ethernet) and AC power.
13. Siren output.
14. Number of devices per zone: As zone required.
15. ULC approved.

## 2.3 DOOR CONTACTS:

1. Surface mounted.

2. All door contacts are to be dedicated for the IAS. They are to be provided by Door Hardware Supplier.

## **2.4 MOTION DETECTOR**

1. 360° Ceiling mount motion detector:
  1. PIR/Microwave Motion Detector
  2. Alarm relay contact type: NC/NO
  3. Detection angle: 360°
  4. Detection radius: 8.2 meters
  5. Installation height: 2.4 ~ 6.1 meters
  6. Operating temperature: 5° ~ 50 °C
  7. Approved manufacturer and part number:
    1. BOSCH DS9370 Panoramic TriTech Ceiling Mount Detector
    2. Or equivalent approved by Owner
2. Wall mount motion detector:
  1. PIR/Microwave Motion Detector
  2. Alarm relay contact type: NC
  3. Detection radius: 18 meters
  4. Installation height: 2 ~ 3 meters
  5. Operating temperature: -29° ~ 55 °C
  6. Approved manufacturer and part number:
    1. BOSCH ISC-PDL1-W18G Motion Detector
    2. Or equivalent approved by Owner

## **2.5 COMMUNICATIONS: MOBILE COMMUNICATOR.**

1. Uses LTE cellular network for high-speed, reliable, and low-cost communications.
2. Compatible with control panels.
3. Full event reporting
4. 4 inputs/outputs in metal enclosure.
5. Wall mounted beside intrusion alarm panel in IT room.
6. Approved manufacturer and part number:
  1. DSC LE4010-TL Cellular Wireless Alarm Communicator,
  2. or equivalent approved by Owner.

## **2.6 CONNECTORS AND SWITCHES:**

1. Comply to ULC-C634.

## **2.7 POWER SUPPLIES:**

1. Comply to ULC-S318, UL 603.

## **2.8 ACS & IAS REDUNDANT SERVERS AND PERIPHERICALS**

1. Provide 1 x set of redundant servers (2 servers) for the ACS and IAS systems. Both servers have to have positive control at all time in the case one server goes down; another server is to be able to takeover for all ACS and IAS functionalities. Each server has to be installed with combined ACS and IAS security management systems.
2. Server Technical Features:
  1. Mounting: Rack Mount Servers (preferable 1U).
  2. Microprocessor: Intel Multi Core Xenon family.
  3. Operating System: Microsoft Windows Server.

4. Hard Drive: 1TB.
5. RAM Memory: 16 GB.
6. LAN Interface: 10/100/1000 Gigabit NIC.
7. Flat Screen Monitors: 27", HD (1920 x 1080 p).
8. Keyboard: Standard Multimedia.
9. Mouse: Optical.

### 3 Execution

#### 3.1 INSTALLATION

1. Install intrusion detection panel and components in accordance with manufacturer's written installation instructions to locations, heights and surfaces shown on reviewed shop drawings.
2. Install panels, intrusion detection system and components secure to walls, ceilings or other substrates.
3. Install required boxes in inconspicuous accessible locations.
4. Conceal conduit and wiring.

#### 3.2 SITE TEST AND INSPECTION

1. Perform verification inspections and test in the presence of Consultant.
  1. Provide necessary tools, ladders and equipment.
  2. Ensure appropriate subcontractors and manufacturer's representatives are present for verification.
2. Visual verification: objective is to assess quality of installation and assembly and overall appearance to ensure compliance with Contract Documents. Visual inspection to include:
  1. Sturdiness of equipment fastening.
  2. Non-existence of installation related damages.
  3. Compliance of device locations with reviewed shop drawings.
  4. Compatibility of equipment installation with physical environment.
  5. Inclusion of all accessories.
  6. Device and cabling identification.
  7. Application and location of ULC approval decals.
3. Technical verification: purpose to ensure that all systems and devices are properly installed and free of defects and damage. Technical verification includes:
  1. Measurements of coverage patterns.
  2. Connecting joints and equipment fastening.
  3. Compliance with manufacturer's specification, product literature and installation instructions.
4. Operational verification: purpose to ensure that devices and systems' performance meet or exceed established functional requirements. Operational verification includes:
  1. Operation of each device individually and within its environment.
  2. Operation of each device in relation with programmable schedule and or/specific functions.

#### 3.3 FIELD QUALITY CONTROL

1. Manufacturer's Field Services:
  1. Obtain written reports from Manufacturer verifying compliance of work, in handling, installing, applying, protecting and cleaning of product.
  2. Submit 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. Ensure Manufacturer's representative is present before and during critical periods of installation, testing.
4. Schedule site visits to review work at stages listed:
  1. After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
  2. Upon completion of work, after cleaning is carried out.

#### **3.4 ADJUSTING**

1. Set up and adjust all IAS components for correct function.

#### **3.5 PROTECTION**

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

#### **3.6 TRAINING**

1. Include three (3) hours of training per session for designated staff in three (3) different sessions within six (6) months of completing the work. The training will be conducted on the premises and will include at least two (2) staff members. The trainer will be a qualified individual accredited by the manufacturer. As part of the training the Owner will be provided with "Cheat Sheets".

**END OF SECTION**

## **1 General**

### **1.1 SUBMITTALS**

1. Submit shop drawings for products specified in this Section. Include annunciator schedules and sample of graphic annunciator layout and nomenclature.
2. Submit copies of final system testing and verification reports and certificates of approvals from local governing inspection authority.
3. System Software
  1. Submit final version of custom system software in format confirmed with CM.
  2. Include copy in system O&M manuals.

### **1.2 SOFTWARE NOMENCLATURE REPROGRAMMING**

1. Include additional costs for system manufacturer to make necessary on site final changes to applicable system/equipment software. Make such changes after successful testing and verification of systems, but prior to turn over to Owner. After successful final verification of work, confirm and obtain approval of final nomenclature in writing from Owner and review with Consultant. Software revisions to incorporate final room names/area names/building names and equipment identification.

## **2 Products**

### **2.1 FIRE ALARM SYSTEM VENDOR REVIEW**

1. With system manufacturer or manufacturer's authorized vendor, review issued Bid Documents for fire alarm system design and verify if any recent code requirements are in effect and need to be accommodated in work. Review systems work on drawings and if any errors or omissions are found, advise Consultant minimum 7 working days prior to close of Bid submission.

### **2.2 FIRE ALARM SYSTEM (BASIC ADDRESSABLE)**

1. Edwards, "EST3" series, CSA approved and ULC listed and labelled components for a fully electrically supervised, addressable, microprocessor based, single stage, zoned, modular, fire alarm system.
2. System components to be listed as products of a single manufacturer under appropriate category, by Underwriter's Laboratories of Canada and bear ULC label. system components and work in conjunction with system installation to meet specific application requirements of local governing authorities, codes, standards, regulations and requirements of following:
  1. CAN/ULC-S524, Standard for Installation of Fire Alarm Systems;
  2. CAN/ULC-S527, Control Units for Fire Alarm Systems;
  3. CAN/ULC-S537, Standard for Verification of Fire Alarm Systems;
  4. CAN/ULC-S1001, Integrated Systems Testing of Fire Protection and Life Safety Systems;
  5. local governing building code;
  6. local governing electrical code;
  7. local governing building permit applications for approvals;
  8. other requirements of local governing authorities.
3. Devices to be ULC listed and labelled devices suitable for fire alarm applications. Power supplies and other components to be CSA approved where required by local governing authorities and codes.
4. System to include following components:
  1. main control panel with liquid crystal display (LCD) and integral light emitting diode (LED) annunciator and system software; capacity for required schedule of zones, system points plus minimum additional spare 25% zones and points;
  2. remote annunciators;

3. alarm initiating devices;
  4. alarm signalling devices;
  5. batteries and battery chargers, end-of-line devices and required ancillary devices;
  6. wiring in conduit.
5. Exact type of device to be used in each area of installation to be as recommended by system manufacturer to suit specific applications and to be approved for such use as per ULC standards. Devices in non-climatic controlled areas to be weatherproof, corrosion resistant and ULC listed for use in below freezing temperatures. System manufacturer to be responsible for ensuring compliance with these requirements.
6. With specific reference to audible and visual devices, determine exact type of devices and output settings to be provided to comply with ULC S524 and local building inspector requirements. Confirm, determine and set output levels of devices to meet local building inspector and ULC S524 dBA audibility and candela visibility levels for each location of devices as noted on drawings. Size power supplies accordingly and with spare capacity and maximum device loading as specified.
7. Control Panel:
1. Control panel features:
    1. surface mounted when installed in unfinished areas;
    2. recessed mounted when installed in finished areas;
    3. solid-state microprocessor based technology with LCD and integral LED annunciator with alarm and trouble LED's for each scheduled zone; annunciator provisions to be common with remote annunciator;
    4. dead front, modular cabinet assembly with trim, hinged door with full glazing, a lock, and keys; door provides access to operator controls, but does not expose live electrical connections; controls, indicators, and operating instructions clearly visible through viewing window; electrical connections are front access through a removable inner protective cover.
  2. Panel allows for loading or editing of special instructions and operating sequences as required and is capable of on-site programming to accommodate expansion and changes required by local codes. Software operations and instructions are stored in a non-volatile programmable memory in event of loss of primary and secondary power.
  3. On site programming changes to fire alarm system is password protected. During construction stage, review with Consultant and obtain approval from local governing fire authority, of programming (system sequence of operation) and custom label changes. System software to be custom programme as required.
  4. Include for system programming changes required for duration of project and as required for final acceptance and certification of entire system and project work, by local governing fire and buildings authorities. Include for additional one (1) onsite system reprogramming sessions (duration minimum 4 hours) for any required revisions, after system verification/commissioning. Provide re-burning as required by local governing fire authority.
  5. Ability to selectively program input/output control functions based on ANDing, ORing, NOTing, Timing, and Special Coded Operations is also to be incorporated in resident software programming of system.
  6. System to have ability to manually disable and enable any device/circuit individually, via software, for maintenance or testing purposes.
  7. System can program selected or all smoke sensors for alarm verification operation.
  8. System can program an adjustable time delay circuit for each water flow initiating circuit to prevent false alarms that may be caused by erroneous pressure surges in sprinkler system.
  9. Wiring to any remote annunciator to be supervised for open and ground conditions.

10. Properly ground and bond control panels and remote annunciator cabinets to building ground. Conduit ground will not be acceptable. Provide green coloured grounding loop, a minimum #10 AWG. insulated copper run in conduit. Connect ground loop to main building ground system source. Do not run ground wire in same conduit as fire alarm and communication wiring.
11. Control panel LCD indicates alarms, supervisory service conditions and troubles. Panel includes but is not limited to following:
  1. minimum 8 lines by 21 characters LCD display;
  2. minimum 2500 addressable point capacity;
  3. minimum 15 hardwired circuit capacity;
  4. local energy, shunt master box, or reverse polarity remote station connection;
  5. form C trouble contact;
  6. earth ground supervision circuit;
  7. front panel ground fault isolation control;
  8. 8 amp intelligent power supply;
  9. automatic battery charger;
  10. standby batteries;
  11. resident non-volatile programmable operating system memory for operating requirements;
  12. five programmable multi-function keys with status LED's;
  13. red fire alarm LED and acknowledge button;
  14. red priority 2 LED;
  15. yellow supervisory service LED and acknowledge button;
  16. yellow trouble LED and Acknowledge button;
  17. green power on LED;
  18. alarm/signal silence LED and button;
  19. system reset button;
  20. operator interface keypad for manual control and system information access;
  21. addressable interface control modules (as required);
  22. serial DACT module;
  23. supervised annunciator circuit.
12. Control Panel is capable of chronologically logging and storing minimum 300 events in an alarm log and minimum 300 events in a trouble log. Historical logs are stored in CPU's memory and are protected by a lithium battery that is supervised for a low battery condition. Each recorded event includes time and date of that event's occurrence. Alarm log file is separate from trouble log file. User to be able to generate a report of both logs upon request.
13. Hardwired initiation and control circuits to be individually configurable, on site, in any combination, to provide initiating circuit, signal circuit, or auxiliary control circuit operation. These circuits include a Ground Fault Isolation Relay, allowing them to be isolated via front panel keyboard without having to remove any field wiring.
14. Initiation circuits/addresses are individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, a non-latching monitoring circuit or an alarm verification circuit.
15. Notification appliance circuits (NAC), (speaker/strobe circuits), are independently supervised and fused such that a fault on one circuit does not affect operation of any of other circuits. NACs are configured as follows:
  1. Class "B" wiring, current limited;
  2. rated at two amps of continuous power;
  3. capable of powering polarized 24 VDC audible/visual signalling appliances;
  4. supply two NAC s per floor.



16. Auxiliary control circuits are as follows:
    1. central Station alarm output;
    2. central station trouble output;
    3. SPDT Form C relays fused at 2 Amp @ 24 VDC.
  17. System Expansion Modules connected by ribbon cables are supervised for module placement. Should a module become disconnected system trouble indicator illuminates and audible trouble signal sounds.
  18. Fire Alarm Control Panel supports 2 RS-232-C I/O ports. CPU data output to I/O ports are in a parallel ASCII format at field adjustable baud rates of 220, 300, 1200, 2400 and 4800. Include updated requirements as required.
  19. System is of modular design to allow future expansion with a minimum of hardware additions and system interruptions.
  20. Isolators to be provided between building dividing walls, where required by local governing authorities and codes and as recommended by system vendor.
  21. Control panel to have minimum 25% spare supervisory and annunciating capacity and provide following functions:
    1. fire alarm control;
    2. fire alarm annunciation;
    3. supervisory and trouble annunciation.
  22. Panel to include circuitry and devices to transmit an alarm signal to device(s) provided by others (Owner's arranged monitoring company) to send alarm signal to Fire Department or to an outside private protection company, in accordance with CAN/ULC-S561. Exact requirements to be coordinated with monitoring company and and/or security company.
  23. Serial digital alarm-communicating transmitter (SDACT) module mounts internally to and communicates directly with fire alarm control panel. SDACT monitors status of host fire alarm control panel and its connections to central station-monitoring receiver. When status changes require information to be reported, SDACT provides a per point message, (i.e. every addressable device within system on an individual basis), that can assist central station in more accurately implementing required response. Typical information reports include alarms, troubles, and supervisory conditions with specific point identification.
  24. Amplifiers and tone generators supply required signals for tones to audible devices and are sized to accommodate audible device loads (assume 1 watt tapping for determination of amplifier capacity). Amplifiers to be continuously supervised for proper operation. Amplifiers to be sized to include 20% power output spare future capacity.
8. Walktest with History Logging:
1. Provide necessary software and programming to provide one-man system testing, as follows:
    1. initiating walk-test mode automatically disconnects auxiliary control circuit relays, and creates a system trouble indication on control panel;
    2. alarm activation of any initiating device causes audible signals to pulse one round of code over alarm signal circuits identifying zone of alarm to testing technician without having to return to control panel; alarm-initiating zone is silently logged as being tested in historical data file. panel automatically resets itself after logging of alarm;
    3. any momentary opening of an initiating or indicating appliance circuit causes audible signals to sound for 4 seconds to indicate trouble condition; trouble condition is silently logged as a trouble condition in historical data file. panel automatically resets itself after logging of trouble condition;
    4. if walktest feature is on for an inappropriate, (programmable), amount of time, system reverts to normal mode automatically;
    5. actuation of walktest program not to require any special tools and be user friendly programmable by authorized user.

9. Power Supply:

1. Control panel accepts 120 volts, 60 Hz as primary source of power for system and additionally provides 24 volts regulated output, current limited distributed system power. Primary power failure or power loss (less than 102 volts) activates common trouble sequence.
2. Direct current (DC) emergency power supply consists of battery power source to supply sufficient standby capacity to operate entire system upon loss of normal power. Emergency power supply controls, battery charger, and batteries provide an automatic un-interruptible transfer of power to loads during primary power failure or loss. During normal operating conditions a fault in battery charging circuit or a short or open in battery leads, to activate common trouble sequence. Continuous supervision of wiring for initiating and alarm circuits to be maintained during power failure.
3. Size batteries in accordance with latest requirements of local governing building code. Batteries to be maintenance free, dual-sealed gelled cell type equipped with charging circuits capable of recharging fully depleted batteries to within 70% of their maximum capacity within 12 hours. Ampere-hour capacity to be adequate to operate system under supervisory conditions for a minimum of 4 hours with AC power disconnected, and to provide emergency power under full load for local governing building code required length of time but which must be at least 30 minutes at end of this period. Confirm exact requirements with local governing fire authority. Test, verify, and demonstrate these requirements as specified in Part 3 of this Section. System automatically transfers to standby batteries upon power failure. Battery charging and recharging operations are automatic.
4. Power supply and control equipment include transient voltage surge protective device as recommended and provided by fire alarm system manufacturer.

10. Addressable Device Network:

1. System provides communication with addressable initiating devices. These devices are annunciated on control panel's main LCD/LED display. Annunciation includes following conditions for each point:
  1. Zone/Device Location;
  2. Type of Device;
  3. Detector Status (Normal/Alarm/Trouble);
  4. Device Missing/Failed.
2. Minimum of 100 addressable devices may be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable.
3. Communication format is completely digital poll/response protocol. A high degree of communication reliability is obtained by using parity data bit error checking routines for address codes and check sum routines for data transmission portion of protocol.
4. Each addressable device to be uniquely identified by an address code entered on each device at time of installation. Use of jumpers to set address is not acceptable due to potential of vibration and poor contact.
5. System supports 100% of addressable devices in alarm or operated at same time, under both primary (AC) and secondary (battery) power conditions. Systems which cannot support 100% of their point capacity in alarm simultaneously are not acceptable.
6. System to allow a line distance of up to 750 m (2,500 feet) to furthest addressable device on a Class A communications circuit. Run each addressable loop wired Class A, and run in a Class A conduit system with return run separated by a minimum of 600 mm (24") from primary run. Appropriate quantity of isolator modules to be installed so that a wiring fault (short, open, or ground) within one floor area does not prevent normal operation of other addressable devices on other floor areas.

11. Remote Trouble Indicator:
  1. Remote trouble indicator unit includes a yellow LED that illuminates and a low frequency piezo that sounds upon a trouble condition being received at main control panel. Unit resets when controlling contact is reset.
12. Addressable Modules:
  1. Addressable modules to be used for monitoring of water flow, valve tamper, non-addressable initiating devices, and for control of fans or dampers that require shutdown or manual control in an alarm condition.
  2. Addressable modules to monitor any N/O contact device and be capable of powering 2-wire smoke detectors. Addressable modules will communicate zone's status (normal, alarm, trouble) to transponder. Addressable modules zone address to be set at time of installation via a dip switch package. Where multiple addressable modules are required within a room, (for example a sprinkler room), cabinet mount addressable modules in a locked box, keyed to match fire alarm control panel. Neatly arrange addressable modules for easy contractor connection and label each addressable module with a lamacoid plate providing zone, device address and custom label.
  3. Addressable modules to be able to provide supervised or non-supervised control of any control function. Addressable modules will communicate zone's status (normal, trouble) to transponder. Addressable modules to provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of relay to be equipped with a replaceable 2 AMP fuse. Addressable modules zone address to be set at time of installation.
13. Manual Stations:
  1. Manual stations to be addressable, single stage, dual action, non-coded type. Stations are of injection moulded Lexan construction with red enamel finish and "LIFT AND PULL HANDLE IN CASE OF FIRE" lettering. Stations include break-glass rod, key reset function and one set of sealed N/O contacts. Activation requires initially lifting cover and then pulling down handle to cause contacts to close, breaking glass rod and activating a fire alarm condition. Reset station with key switch. Include auxiliary contacts for interconnections to other equipment.
  2. Addressable manual station electronics including diagnostic LEDs are mounted on station and distinct address is set on station at time of installation.
  3. Manual stations in areas designated as barrier free to be of type operated with no grip handle as approved by local governing authorities and as recommended by system manufacturer.
  4. Include plaster cover for semi-flush mounting and suitable back box. Where surface mounted include for compatible surface mounted style red box. Include additional auxiliary set of contacts where required for interconnection to other building systems.
  5. Equip stations located in areas of high abuse or where designated to be complete with guard, with STI type, ULC listed and labelled, hinged clear Lexan cove. Where specified or where required by code or local fire authority, include integral audible alarm to sound when cover is opened.
  6. For non-climate controlled applications, provide weatherproof STI type, ULC listed and labelled, hinged clear Lexan cover. Where specified or where required by code or local fire authority, include integral audible alarm to sound when cover is opened.
  7. Provide wire guards over stations identified as "WG".
14. Thermal Detectors:
  1. Surface ceiling mounted addressable automatic thermal detectors with features as follows:
    1. low silhouette design and twist-lock mounting to base;
    2. integral microprocessor with non-volatile memory, automatic device mapping, electronic addressing, self-diagnostics and history log;

3. LED status indication;
    4. field configurable mounting mechanism to prevent unauthorized removal;
    5. combination 135°F (57°C) fixed temperature and 15°F (9°C) rate-of-rise type;
    6. 135°F (57°C) fixed temperature type.
  2. Each detector to be complete with a base plate for mounting to a standard 4" (100 mm) outlet box and cast guards for detectors. Where required, provide an additional alarm relay (Form C, SPDT), normally open contact, for auxiliary functions.
15. Ceiling Mounted Products of Combustion Detectors:
1. Surface ceiling mounted photoelectric type, addressable, products of combustion (smoke) detectors with features as follows:
    1. low silhouette design and plug-in mounting to base;
    2. integral microprocessor with non – volatile memory, automatic device mapping, electronic addressing, self-diagnostics and history log;
    3. sensitivity range from 0.6% to 1.9% per foot;
    4. environmental compensation;
    5. identification of dirty or defective detectors;
    6. an integral LED alarm lamp;
    7. locking feature to prevent unauthorized removal of unit head from base.
  2. Each detector to be complete with a base plate equipped with wiring terminals, for mounting to a standard 4" (100 mm) octagon box. Provide cast guards for detectors where identified on drawings. Where required, provide an additional alarm relay (Form C, SPDT), normally open contact, for auxiliary functions.
  3. Detectors tied to hold open devices to be complete with required auxiliary set of contacts. Co-ordinate work with supplier of hold open devices.
  4. Equip detectors with a dust cover, to be removed at time of verification to prevent dust and dirt entering smoke chamber during construction work.
16. Detector Bases:
1. Various types of bases are required to suit each respective application. Confirm with system manufacturer, and provide required type for each application. Types include:
    1. standard type equipped with wiring terminals, for mounting to a standard 100 mm (4") octagon box and complete with tamper-resistant mechanism to prevent unauthorized removal of unit head from base;
    2. relay type with features similar to standard type but includes auxiliary relay;
    3. audible type with features similar to standard type but includes an audible alarm sounder;
    4. isolator type with features similar to standard type but includes line fault isolator.
17. Duct Mounting Products of Combustion Detectors:
1. Duct type smoke sensor units with features as follows:
    1. addressable photoelectric detector features;
    2. duct air sampling tube of suitable required length;
    3. magnetic activated test switch;
    4. status LEDs;
    5. Form C auxiliary alarm relays;
    6. remote alarm indicator assembly with LED type lamp and single gang stainless steel faceplate;
    7. remote test station for detectors in locations not easily accessible to test.
  2. Duct housing assembly consists of an airtight housing mounted on side of duct, and contains sensor base into which photoelectric sensor head is inserted.

3. For units located within ductwork as shown on drawings and for units within air intake ductwork, provide weather resistant and corrosion resistant housing complete with integral heater and power supply, and thermostat controller with alarm contacts for monitoring and annunciation of low temperature. Provide system wiring in conduit back to transponder/control panel.
18. Audible/Visual Devices:
  1. Devices include bells, horns/speakers, strobes and combination units. Devices to mount on wall back boxes. Audible devices for same applications, to sound alike on system as approved by local governing authorities. Back boxes to be supplied by system manufacturer to suit specific devices and type of installation. Confirm finish colours with Owner and review with Consultant prior to ordering.
  2. Audibility levels and candela levels of devices to be field selectable and adjustable to suit local codes and standards for various applications, such as sleeping rooms. Subject to review with Consultant, system vendor to select and adjust levels as required to meet local governing authority and code requirements for final installed system. Audible and visual devices to be of similar sound and pattern.
  3. Bells to be with features as follows:
    1. 24V vibrating bells, 150 mm (6") diameters;
    2. alloy steel gongs, cast aluminum base, red enamel finish;
    3. sound level of minimum 92 dBA at 3 m (10');
    4. complete with mounting plate;
    5. where recess mounted include for recessed wall box and prime painted grille.
  4. For finished areas: re-entrant type horn and horn/strobe units with features as follows:
    1. flush mounting and surface mounting to suit applications;
    2. temporal or continuous tones to meet local governing authority requirements;
    3. minimum 94 dba @ 3 m (10') at low setting and minimum 98 dba @ 3 m (10') at high setting;
    4. faceplate of impact resistant construction, finished in colour reviewed with Consultant;
    5. integral synchronized strobe to be complete with Lexan lens, field changeable "FIRE" markings and candela output intensity as approved by local fire authority (range from 15 cd to 110 cd, and to 177 cd for specific applications);
    6. back box suitable for flush or surface wall mounting applications to suit applications.
  5. Stand alone strobes to be similar to features of combination units specified above but only with strobe features.
  6. In finished areas, devices to mount to a 100 mm (4") square, 60 mm (2-1/8") deep, back box. Where devices are to be surface mounted, provide a red finished surface back box with no knockouts.
  7. Devices mounted exterior to be complete with "weatherproof" box.
19. Visual Notification Appliances (Strobe Lights):
  1. Visual notification appliances to be ULC listed and labelled, Wheelocks Series RSS, or approved equal, synchronized, suitable for intended application with input polarized for standard reverse polarity supervision by fire alarm controls and designed with zero inrush current at 15, 30 and 110 candela intensities, and to 177 cd for specific applications. Exact intensities to be to fire authority requirements and as approved by Consultant. Exterior mounted units or units mounted in non-climate controlled areas to be equal to type RSSWP weatherproof type strobes with weatherproof backbox.

20. Wiring:
  1. CSA approved and ULC listed wire and cable, approved for fire alarm circuits; with colour coded, insulated solid copper conductors; of type as per local governing electrical code and local governing fire authority requirements; sized and installed in accordance with system manufacturer's instructions.
  2. nVent "Pyrotenax" type "MI" ULC listed and labelled and 2 - hour fire rated, mineral insulated, copper sheathed, copper conductors for power wiring to and between each transponder/control panel and applications as required by local governing codes and authorities, and applications as indicated.
21. End-of-Line Resistors:
  1. End-of-line resistors for standard alarm and signalling circuits, sized to ensure correct supervisory current flows in each circuit, as per local governing code requirements and system manufacturer's recommendations.
  2. Mount end-of-line resistors on a stainless-steel plate suitable for mounting on a standard single gang wall box.
22. Isolators:
  1. Isolators to be provided in accordance with local governing code requirements and installed as per system manufacturer's requirements to isolate/monitor zones, loops, group of devices within building and between buildings.
23. Warranty:
  1. Warranty to include following:
    1. one year repair or replacement warranty on components; full labour costs and no deductible;
    2. warranty to begin upon Substantial Acceptance of Project, or where applicable, phase of Project; provide extended warranty for system if used during construction stages and to cover period of construction before turn over to Owner;
    3. support of an operational remote maintenance capability;
    4. repair response times for problems defined as routine to be addressed and corrected within 24 hours, excepting statutory holidays and weekends;
    5. repair response times for problems defined as major to be addressed and corrected within 4 hours, excepting statutory holidays and weekends;
    6. requirement to have at least one full system of each model provided available in installation area for immediate installation, in case of an entire system failure or catastrophe; such undertaking to be set out in an acceptable plan;
    7. manufacturers of major components to provide written confirmation of full warranty, extended warranty and service back-up in case of failure to perform or insolvency of successful supplier.
24. System Inspection, Testing and Verification:
  1. Include for system manufacturer's onsite system inspection, testing, verification and certification work, as per requirements specified in Part 3 of this Section. Note that failure to perform such work to complete requirements specified, may at Owner's discretion, affect progress draws and holdbacks.
25. Acceptable Manufacturers (products and work to be provided directly from manufacturer, unless otherwise noted):
  1. Edwards (from Troy Life and Fire Safety, or Chubb Fire Safety);
  2. Johnson Controls formerly Tyco-Simplex (from Johnson Controls [Tyco Integrated Fire & Security]);
  3. Siemens Building Technologies (from Siemens);
  4. Honeywell - Notifier (from Notifier authorized regional vendors);

## 2.3 ADDITIONAL DEVICES

1. Include for 5 additional main type of audio devices and 5 additional strobe lights, each with 20 m (60') of wiring in conduit, installation, programming, testing and verification. Install these additional devices in event of local fire/building inspector requiring additional coverage in certain areas.

## 3 Execution

### 3.1 INSTALLATION - GENERAL

1. Prior to start of Work as part of shop drawing submission process, review with system manufacturer following:
  1. device types to ensure that selected type is suitable for intended application on project;
  2. selection of audible and visual devices with field adjustable settings to suit various installation areas and applications and to meet local code ds and standards including ULC S524;
  3. locations of devices to ensure proper operation and coverage are in compliance with requirements of local fire authorities;
  4. device mounting heights to ensure proper operation and coverage are in compliance with requirements of local fire authorities;
  5. device back box requirements to ensure size and depth suit system manufacturer's recommendations for specific devices;
  6. types of system wiring and required sizing taking in consideration applications and voltage drop;
  7. system circuiting and device quantities per circuit while maintaining limitations in Specifications;
  8. proposed system sequence of operation.
2. Immediately advise Consultant of any requirements of above that may necessitate revisions to design documents.
3. Obtain required training from manufacturer's representative on any special installation procedures. Install devices and perform work in accordance with the manufacturer's instructions and requirements and in accordance to applicable codes of the governing authorities having jurisdiction.
4. Provide fire alarm system for building in accordance with issued documents and to approval of local governing authorities. Install, test, verify, and certify system as per latest recognized standards indicated herein, local governing building code and as required by local governing fire authority.
5. In addition, work to meet Owner's standards, and recommendations and instructions from system manufacturer.
6. Perform Work in conjunction with this installation to meet requirements of latest editions of local governing building code, local governing electrical code, ULC Installation Standard CAN/ULC-S524, and any applicable local codes. If any requirements of these specifications are different, omitted or contrary to ULC-S524 Standard, then ULC Standard governs and overrides these specifications, but in no instance will standards established by drawings and specifications be reduced by any of Codes referred to previously. Control units and annunciators to be in accordance to latest requirements of ULC Standard CAN/ULC-S527 "Control Units for Fire Alarm Systems.

### 3.2 SYSTEM PROGRAMMING

1. Include for system manufacturer's authorized technician to perform system programming work, work within control equipment and final equipment connections. Include for manufacturer's authorized representative to perform specified on site software programming sessions for Owner's changes, to system after total completion of work and verification of system.

2. Provide sequence of operation for fire alarm system as approved by local fire authority and reviewed with Consultant. Contact Owner's fire Consultant with regards to requirements of sequence of operation and any other requirements of system. Submit sequence of operation and proposed graphic displays to local fire authority for approval and Consultant for review during shop drawing submissions. Refer to additional requirements on drawings.
3. Upon completion of Work, demonstrate system to local Fire Department and obtain their approval for complete system.
4. Custom programme sequence of operation with provisions to allow authorized Owner's users to make revisions easily. Following sequence of operation to be considered for Bid Pricing purposes. Exact sequence must be approved by local fire authority and Consultant prior to start of work. Refer to drawing schedule of operations. Submit proposed sequence with shop drawings. Actuation of any alarm initiating device to cause following single stage sequence of operations:
  1. audible devices to sound continuously;
  2. visual devices to illuminate;
  3. zone of alarm condition to be indicated at control panel annunciator and remote annunciator;
  4. zone and address of device in alarm condition to be indicated at control panel annunciator and remote annunciator;
  5. activation of circuitry to transmit an alarm signal to device(s) provided by others (Owner's arranged monitoring company) to send alarm signal to Fire Department or to an outside private protection company; this work to comply with CAN/ULC-S561;
  6. designated air handling equipment to start-up or shut-down by means of control wiring from control panel to equipment starters;
  7. release door holders.
5. Unauthorized closure of a fire protection system piping supervised valve to cause location of closed signal (audible and visual) to sound and illuminate, and a trouble signal to be transmitted (via a future connection) to Fire Department or to an outside protection agency.
6. Low pressure in fire protection piping mains (wet and dry), fire protection system pumps (fire pumps-standpipe system excess pressure pump-sprinkler pump, sprinkler system excess pressure pump) loss of power, or operation of fire pumps to also activate audible and visual trouble alarm as specified above for supervised alarms.

### 3.3 INSTALLATION OF CONTROL UNITS

1. Install control panel in locations. Mount equipment and connect complete in accordance to manufacturer's instructions and requirements. Arrange for manufacturer's authorized representative to program system with required sequence of operation. Review exact sequence of operation with Consultant prior to programming.
2. Install units in accordance with manufacturer's instructions.
3. Connect panels to dedicated breakers in electrical panel (typically on emergency power) as required or as scheduled. Ensure that room housing panels have fire rating to local governing code requirements.
4. Where required by Code and/or local authorities, that power and control wiring connections to control panel and annunciators and from control panel to annunciators are to be fire rated, provide fire rated, ULC listed, conductors (MI) to provide code required fire rating.
5. Provide remote annunciator and adjacent graphic annunciator in location. Unless otherwise noted, install in main entrance vestibule. Co-ordinate backbox installation with general trades work of wall structure. Submit annunciator schedule with shop drawings. Review zone nomenclature with Consultant prior to installation. Provide proposed drawing and sample of graphic display to Consultant for review before manufacturing.



6. Properly ground and bond panels and required components to building ground. Conduit ground will not be acceptable. Provide green coloured grounding loop, a minimum #10 AWG insulated copper conductor run in conduit. Connect ground loop to main building ground system source. Do not run ground wire in same conduit as fire alarm and communication wiring.

### 3.4 INSTALLATION OF DEVICES

1. Install required devices. Do not install devices in locations that may hamper proper operation of devices including adjacent devices.
2. Install wall mounting manual stations in locations and connect complete. Install flush mounted units in a standard 100 mm (4") recessed outlet box with plaster cover. Stations in unfinished areas to be typically surface mounted. Coordinate type and size of backboxes and outlet boxes with system manufacturer prior to ordering. Install surface mounted units in manufacturers supplied surface boxes. Comply with mounting height requirements for local governing building code barrier free access.
3. Install mounting plate of detectors to ceiling mounted boxes as required. Secure detectors to plates. Secure plate of each detector to a 100 mm (4") outlet box or surface mounted as required. Refer to floor plans and drawing symbol list to determine type and rating of detectors in any given area. Generally, do not install rate-of-rise type detectors in areas subject to sudden changes in temperatures, such as entrance vestibules. Confirm application requirements with system manufacturer and ensure that devices are ULC listed for such applications and are approved by local fire authority for such use.
4. Where applicable, provide wiring in conduit and connections from smoke detector auxiliary relays to door hold open devices. Co-ordinate work of respective trades.
5. Install cross zoned connection of detectors and remote indicating devices for areas of raised floors or within accessible ceiling spaces or for applications detailed on drawings.
6. Mount each duct mounted products of combustion detector on duct in question and connect with smoke sampling tubes which extend into duct air stream. Install a remote alarm lamp assembly for each duct mounted detector. Wall mount each lamp assembly on a standard 100 mm (4") outlet box as close as possible or practicable to detector. Do not locate duct detectors within 1 m (3') of duct size increaser or decreaser fittings or any duct elbow. Provide wiring in conduit and extend to connect back to system control unit.
7. Work to include provision of fire alarm devices (flame detectors, smoke detectors, audible/visual devices) in genset enclosures. Refer to drawings for device types. Genset enclosure is constructed with conduits and boxes to accommodate these future fire alarm devices. Install required devices and wiring. Extend wiring from devices to enclosure termination box. Extend from termination box to main building and connect to fire alarm system. Coordinate work with genset enclosure vendor.
8. In application with hold open devices on doors, ensure compliance with NFPA regarding smoke detectors tied to hold open devices such that a signal received directly from smoke detector must cause release of door. Where electromagnetic locks are used on doors of egress, provide required automatic release of locks upon activation of fire alarm. Provide required connections to fire alarm system and to electromagnetic locks, and provide required contactors and/or relays for connection to control panel.
9. Provide combination and standalone audible devices and visual devices on standard device boxes in locations. Ensure that sound levels and visibility levels are in accordance to requirements of applicable local governing codes and standards, requirements of local governing inspectors, and as required by on site coverage tests. Provide required light and sound meters and personnel to perform tests. Adjust tapping, or relocate respective devices to suit, or provide additional devices, as required to provide levels to satisfy testing and governing authority requirements.

10. Provide required speakers. Speakers are flush and surface mounted cone type and as indicated to suit architectural wall/ceiling types, each complete with a proper backbox. Install and circuit as required and in accordance with manufacturer's instructions for specific applications.
11. Exterior speakers/horns to be weatherproof and vermin resistant and mounted with weather sealed gland nut connection at proper dispersion angle.
12. Typically, wire speakers/horns in Class B, 2 wire circuit configurations, terminating in end of line devices. Wire alternate speakers in same circuits with a minimum of 2 circuits per floor.
13. Install devices in stairwells to suit audible/visual coverage requirements and local code requirements. Circuit as required by local code requirements.
14. Generally, audible device locations are indicated on drawings, however, exact audible device quantities and locations to be in accordance with results of audibility device coverage site tests. Provide suitable sound detection metering and personnel to make necessary tests. Relocate audible devices and/or provide additional audible devices as required.
15. Support flush ceiling mounted speaker backboxes from structure and not suspended ceiling grid or tiles. Connect speakers to specified taps and ensure that sound levels are in accordance with local authority and sound level requirements. Adjust as required and certify that levels are in compliance with Code level requirements. Audible devices to be synchronized.
16. Typically, install visual notification appliances 2400 mm (8') above floor or 300 mm (12") below finished ceiling line. Provide visual notification devices in areas subject to high ambient noise levels, such as mechanical equipment rooms, computer equipment rooms, parking garage, etc., and areas designated for hearing impaired as per local building code requirements. Typically, provide minimum 2 circuits per floor and connect devices in alternating scheme.
17. Install amplifiers sized as required to power additional speakers and include spare 20% capacity unless otherwise noted.
18. Install fire signs in locations and connect such that activation of fire alarm system illuminates sign and when system is reset and alarm has been silenced, sign is de-energized.
19. Install and circuit devices in accordance with manufacturer's instructions for specific applications and in accordance with referenced ULC S500 device standards and requirements of local governing authorities. Unless otherwise noted in Contract Documents and reviewed with Consultant, do not load device circuits more than 80% capacity.
20. Devices in non-climate controlled areas to be weatherproof, corrosion resistant, ULC listed for operation in below freezing temperatures, and as recommended by system manufacturer for use for each specific application. Where electronics are not recommended for cold temperature applications, include for manufacturer's recommendations and directions in remotely locating addressable modules in closest heated areas and connecting to respective device in non-climate controlled areas.

### **3.5 REQUIREMENTS FOR INTEGRATED SYSTEMS AND EQUIPMENT**

1. Provide voltage-sensing relays in each phase, line side, of fire pump controller and standpipe system excess pressure pump starters to sense loss of line voltage. relays are to be energized from 15 A-1P breakers and are to be complete with "C" contacts, one per phase, which, if any one phase voltage drops below 90% of nominal, trouble alarm to signal in fire alarm system indicating "Fire Pump Loss of Voltage" or "Standpipe Excess Pressure Pump Loss of Voltage" at annunciators.
2. Provide auxiliary N.O. contact in fire pump controller and connect to fire alarm annunciators, powered from fire alarm system to indicate "Fire Pump Running".

3. Perform required fire alarm system wiring connections to mechanical equipment and other building systems to perform required interrelated functions. Provide required wiring, relays and/or contactors between fire alarm system and various equipment to achieve automatic or manual control of equipment, to perform required integrated to fire alarm system functions. Provide shunt trip breakers as required. Provide ULC listed fire rated conductors where required by local codes and local authorities.
4. In addition to wiring connections to fire alarm system components, extend control wiring in conduit to (where applicable):
  1. fire protection system piping supervised valves and flow switches for alarm initiation;
  2. fire protection system piping supervised valves and flow switches for trouble indication;
  3. fire protection piping pressure sensors for loss of pressure trouble indication;
  4. fan equipment starters;
  5. pumps;
  6. dampers;
  7. fire suppression systems;
  8. door holders/releases and electromagnetic locks master release/reset;
  9. telephone system key switch/PBX for connection to offsite central monitoring station;
  10. telephone system key switch/PBX for connection to allow for integrated general paging with voice communication system;
  11. fire pump transfer switch;
  12. security systems;
  13. BAS system;
  14. dimming systems;
  15. background music systems and sound systems to mute in event of emergency paging;
  16. genset control panel;
  17. central inverter for emergency lighting;
  18. devices and equipment as shown on drawings.
5. Interconnect fire alarm system to security system to provide a common "Alarm" signal to security system controls to release locked doors (designated by Owner) throughout the building on any or designated alarm condition. Interconnections between local fire alarm manual stations and local security system components door hardware to be provided in this manner. Coordinate work with respective system vendors and door hardware trade. Provide manual control switches for release and reset and mount onto control panel. Clearly label operators. Comply with local governing authorities regarding these requirements. Coordinate with General Contractor to obtain required Certificates of Approval for Work.

### 3.6 ADDITIONAL REQUIREMENTS

1. Provide required system wiring in accordance with local governing code requirements, system manufacturer's recommendations and based on specific applications and consideration of voltage drop.
2. Install wiring in conduit unless otherwise approved by Owner and reviewed with Consultant, and except for MI fire rated type. Perform wiring connections associated with fire alarm system on terminal strips in junction boxes and colour coded. Splices are not permitted. Ensure that wiring colour coding is consistent for entire length of each run. When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. Clearly identify wiring at each termination point. In addition, number wiring with Brady Ltd. or Electrovert Ltd. Z-type markers. Colour conductors for each part of system in accordance with system equipment manufacturer's recommendations. Paint conduit couplings red of paint type suitable for application to standards of Division 09.
3. Install wiring in accordance to requirements latest edition of applicable governing electrical code and to requirements of local governing authorities.

4. Where required by local governing codes and/or local governing authorities, provide ULC listed, fire rated conductors (MI) for connections to and interconnections between equipment for life safety applications requiring fire rating. Install MI type conductors in accordance with manufacturer's instructions and requirements in Specification.
5. Run alarm indicating circuits (speakers/strobes/horns) and alarm receiving circuits (manual stations, detectors) in separate conduits from each other.
6. Arrange sprinkler system alarm valve alarm zones to be separate from manual station, thermal detector and products-of-combustion detector device zones, which may be connected together into zones.
7. Provide required double voltage relays for fire alarm wiring work. Provide double voltage relays, with multiple contacts as required, to shut down designated fans. Arrange relays to be energized at all times from fire alarm system to ensure that they are fail-safe.
8. Provide engraved Lamacoid identification nameplates for each equipment or wiring housing and secure to front of housing. Exact wording designations and sizes to be reviewed with Consultant prior to manufacture. Label devices as required by ULC S524 and local governing authorities.
9. Review nomenclature of annunciator identification with Consultant and obtain necessary approvals prior to ordering.
10. Install end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above a manual station location or in equipment rooms as reviewed with Consultant. Provide isolators and install in accordance with ULC standards. Properly label and identify. Do not locate end-of-line resistors and isolators in concealed locations. Generally, install in equipment rooms.
11. Refer to drawing riser diagram. Riser drawings are diagrammatic and are not to be used for determining quantities or lengths. Quantities of components to be as per floor plans. Determine exact quantities of circuits based on drawings information, connected devices, requirements of governing codes and standards, and recommendations of system manufacturer.
12. Review exact location of components with Consultant prior to roughing-in.
13. Where applicable, review component finishes with Consultant prior to ordering.
14. Perform required training and instructions to Owner's staff.

### **3.7 SYSTEM TESTING AND VERIFICATION**

1. Submit to Owner and Consultant, proposed schedule for testing and verification of system. Obtain such reviews prior to start of testing. Consultant and/or other Owner's representatives to have option to witness all or part of testing and verification work. Notify Consultant and Owner minimum 7 working days in advance of testing.
2. When system work is complete and ready for acceptance, arrange for fire alarm system manufacturer's authorized technician to inspect, test, verify, and certify equipment, including initiating devices, signalling devices, control devices, and wiring. inspection to comprise of an examination of such equipment in accordance with latest editions of CAN/ULC-S537 and CAN/ULC-S1001, for following:
  1. to ensure that entire system functions in accordance with sequence of operations on drawings and as specified;
  2. to ensure that type of equipment installed is that designated by contract documents;
  3. to ensure that wiring connections to equipment components show that installer observed applicable ULC and CSA requirements;
  4. to ensure that equipment was installed in accordance with ULC S524 and manufacturer's recommendations, and that signalling devices of whatever manufacture were operated or tested to verify their operation;

5. to ensure that supervisory wiring of those items of equipment connected to a supervised circuit is operating and that governmental regulations, if any, concerning such supervisory wiring, have been met to satisfaction of inspecting officials;
  6. to ensure that system backup batteries provide sufficient backup power as per local governing building code and local fire authority requirements;
  7. to ensure that system audible devices provide alarm sound levels and visual devices provide sufficient candela levels in each area as per requirements of local governing building code, local fire authority and ULC S524; site adjust tap settings of devices as required to achieve required levels;
  8. to ensure that system visual display devices are located in areas as per local governing building code and local fire authority requirements;
  9. full review, testing and verification of operation of integrated systems such as elevators and their emergency sequence of operation, supervisory annunciation of sprinkler/standpipe monitor switches, pressure switches and flow switches, diesel genset alarms, security alarms, BAS alarms, release of door holders and electromagnetic locks, and any other integrated components; coordinate requirements with trades responsible for integrated components and systems who will be present at time of testing and verification work;
  10. to ensure that each device is commissioned and operable.
3. Include for full demonstration to Consultant that system batteries and audible/visual devices comply with specification and code requirements.
  4. Where applicable, assist in testing and verification of electromagnetic door locks to meet requirements of authorities having jurisdiction and to obtain overall approval of installation.
  5. Contact local fire authority inspector and coordinate and arrange for Fire Inspector to perform required inspections. Integrate local fire authority inspection requirements with testing and verification work to extent as per Fire Inspector's directions. Obtain full approval and certification by local fire authority.
  6. Local fire authority inspector, Consultant and Commissioning Agent to at their discretion test system or parts of system in their review of test reports. Correct/repair any failures or deficiencies found in system, whether or not identified in test reports of manufacturer. Re-test and re-verify failures and deficiencies until successfully passed, at no extra cost to Owner.
  7. Obtain from local fire authority required certificate of approval of system and forward to Consultant.
  8. Arrange for manufacturers to supply reasonable amounts of technical assistance with respect to any changes required to conform to paragraphs above. During period of inspection, testing and verification, make Electricians available to do any required correction work and to assist during this Work. Include for trades responsible for integrated components (i.e. exhaust fans, sprinklers, elevators, gensets, etc.) and systems to be present at time of testing and verification work.
  9. Provide full detailed test sheets of tested components and provide certification that system work has been fully tested, that devices have passed testing and that system is in proper work order in compliance to local governing code requirements and project documents. Documentation to be in form in compliance with referenced standards, acceptable to local governing authority having jurisdiction and reviewed with Consultant. Testing report documents to be additionally provided in electronic format as reviewed with local governing authority having jurisdiction and Consultant.
  10. On completion of verification, inspection and testing of system, obtain from manufacturer and forward to Consultant, a verification certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Manufacturer's technician to prepare and sign verification certificates and inspection reports, confirming that system is installed, is working in accordance with requirements specified above and that system has been approved and accepted by local governing fire authority.

11. Obtain from system manufacturer and forward to Consultant a certificate of liability insurance of minimum amount of Two Million Dollars (\$2,000,000.00), that is to be registered for this project to show satisfactory proof of manufacturer's liability coverage for both their product and personnel.
12. Do not use open flame and/or smoke for testing unless approved by Owner and reviewed with Consultant.
13. Testing technicians to be registered technicians in good standing with Canadian Fire Alarm Association (CFAA) or be a Certified Fire Alarm Electrician (CFAE) with Electrical Contractors Association of Ontario (ECAO) as deemed acceptable to Ontario Fire Marshall.
14. Submit with test reports, copies of valid certification of testing company and technician.
15. Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

### **3.8 TRAINING**

1. Manufacturer's trained technician to perform onsite training of each user (including the provision of user guides) prior to project completion to ensure that users are properly trained in the operation and maintenances of system.
2. Refer to Instructions to Owner specified in Section entitled Electrical Work General Instructions.

**END OF SECTION**

**1. GENERAL**

**1.1 References**

- 1.1.1 ASTM D4791, Test Method for Flat or Elongated Particles in Coarse Aggregate.
- 1.1.2 City of Welland Municipal Standards, latest version
- 1.1.3 Ontario Provincial Standard Specifications, Volume 7 – Municipal Construction Specifications

**1.2 Samples**

- 1.2.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- 1.2.2 Allow continual sampling by the Engineer / Consultant during production.
- 1.2.3 Provide the Engineer / Consultant with access to source and processed material for sampling.
- 1.2.4 Install sampling facilities at discharge end of production conveyor, to allow the Engineer / Consultant to obtain representative samples of items being produced. Stop conveyor belt when requested by the Engineer / Consultant to permit full cross section sampling.
- 1.2.5 The Contractor shall pay the cost of sampling and testing of aggregates that fail to meet specified requirements.
- 1.2.6 Provide water, electric power and propane to the Engineer / Consultant laboratory trailer at production site.

**1.3 Measurement and Payment**

- 1.3.1 Work outlined in this section is included in the lump sum tender price.

**2. PRODUCTS**

**2.1 Materials**

- 2.1.1 Aggregate quality shall be: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.
- 2.1.2 Flat and elongated particles of coarse aggregate to meet ASTM D4791 specification:
  - .1 Greatest dimension to exceed four times least dimension.
- 2.1.3 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:
  - .1 Natural sand.

- .2 Manufactured sand.
- .3 Screening produced in crushing of quarried rock, boulders, gravel or slag.
- 2.1.4 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:
  - .1 Crushed rock.
  - .2 Gravel and crushed gravel composed of naturally formed particles of stone.
  - .3 Light weight aggregate, including slag and expanded shale.
- 2.1.5 The loose unit weight of the cover aggregate must meet the ASTM c29 specification. For optimum asphalt requirements of 25 per cent, the volume of chip seal shall range from 0.16 to 0.20.

## **2.2 Source Quality Control**

- 2.2.1 Inform the Engineer / Consultant of proposed source of aggregates and provide access for sampling at least 10 working days prior to commencing production.
- 2.2.2 If, in opinion of the Engineer / Consultant, materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.
- 2.2.3 Advise the Engineer / Consultant 10 working days in advance of proposed change of material source.
- 2.2.4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

**END OF SECTION**



**1. GENERAL**

**1.1 Intent**

- 1.1.1 This Section covers the Work for site clearing, excavating, backfilling and grading for structures and pipes to within 600 mm of structures or walls.
- 1.1.2 Work included is as follows:
  - .1 Excavating
  - .2 Fill and backfill
  - .3 Rough and finish grading
  - .4 Disposal of unwanted material
- 1.1.3 "Trenching", "pipe bedding" and "concrete encasing" referred to is for the area inside structures and to 600 mm beyond the exterior walls.
- 1.1.4 Manage excess soils according to Ontario Regulations.

**1.2 Standards**

- 1.2.1 Comply with the latest versions of:
  - .1 Ontario Building Code
  - .2 Ontario Regulation 406/19
  - .3 Ontario Provincial Standard and Specifications (OPSS)
    - .1 OPSS 180 - Management of Excess Materials
    - .2 OPSS 1004 - Aggregates, Miscellaneous
    - .3 OPSS 1010 - Aggregate, Base, Subbase, Select Subgrade and Backfill Material
    - .4 OPSS 1205 – Clay Seal
  - .4 ASTM D6938

**1.3 Existing Conditions**

- 1.3.1 Take over site based on condition at time agreed upon with Contract Administrator and documented in the Construction Schedule.
- 1.3.2 Should excavated materials be suspected of containing hazardous materials or contaminated soils be encountered in the course of sitework, stop work and notify the Contract Administrator immediately. Do not proceed until written instructions have been received.
- 1.3.3 Geotechnical Engineering Report(s) have been prepared for the detailed design of the new Facility. The information contained in the Report(s) may be utilized by the Contractor for the planning of work and design of the systems covered under this Division including excavation and trenching, excavation support systems, and dewatering systems. Additional boreholes may be required for the detailed design of these systems. The Contractor shall review all existing available information during tendering and allow for additional Geotechnical investigations, as required to facilitate their design.

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- 1.3.4 The followings Geotechnical Reports are available for review and appended to the Contract Documents:
- .1 Geotechnical Investigation, Proposed Single Story Institutional Building, 5 Lincoln Street, Welland, Ontario, Niagara Testing & Inspection Ltd., October 26, 2022.
  - .2 Excess Soil Management Report, Proposed Single Story Institutional building, 5 Lincoln Stret, Welland, Ontario, Niagara testing & Inspection Ltd., October 20, 2022.
- 1.3.5 No guarantee regarding the accuracy, applicability and completeness of the existing investigations is provided to the Contractor. The Contractor shall assume full responsibility for interpretation and use of available soil/groundwater information, planning and execution of excavation and trenching work, temporary support systems, and dewatering systems. Claims arising from the interpretation of available factual information will not be considered.
- 1.3.6 Where available information and reports are not sufficient for the Contractor to evaluate existing conditions, the Contractor shall undertake additional geotechnical investigations (at his own cost). The available documents shall be reviewed at the time of tendering and the cost of additional evaluations incorporated into the Contractor's price for undertaking the design of all temporary works.
- 1.4 Existing Utilities**
- 1.4.1 Contact the various utility companies prior to commencing Work and become informed of the exact location of utilities and protect them during construction and assume liability for damage to them.
- 1.4.2 Utilities that require relocation will be the responsibility of the utility company concerned at no expense to the Contractor. Cooperate with the utility companies and always provide them free access to their facility.
- 1.4.3 Where existing pipes, ducts, or other underground services intersect the pipe trench, support them in a manner acceptable to the utility company and Contract Administrator.
- 1.4.4 Where existing overhead pole lines are adjacent to the excavation, temporarily support them in a manner acceptable to the utility company and Contract Administrator.
- 1.5 Existing Drainage**
- 1.5.1 Maintain temporary and permanent flow in sewers, drains, gutters, ditches, swales and inlet connections.
- 1.5.2 Prevent debris from blocking surface drainage system, mechanical and electrical systems which must remain in operation.
- 1.6 Management of Excess Materials**
- 1.6.1 As part of the design component of the project, certain planning documents have been completed, or partially completed as noted in the Section and the Contract Documents. The Contractor and the Contractor's Qualified Person (QP), shall review and understand the available environmental data on the Excess Soils to

be generated as part of the Project. The overall on-site and excess soil management plan shall refer to and be based on these documents.

- 1.6.2 Management, potential re-use, and disposal of excess soil shall be completed in accordance with all applicable laws and Regulations, including O.Reg. 406/19 requirements.
- 1.6.3 The Contractor shall retain the services of a Qualified Person (QP), as defined in O.Reg. 406/19, for the purposes of completing on-site and excess soil management bin accordance with on O.Reg. 406/19 and all applicable supporting regulations. The Contractor's QP shall be familiar with the objectives of O.Reg. 406/19 which encourages the beneficial reuse of excess soil in a manner promoting sustainability and the protection of the environment and make every effort to meet the objectives of O.Reg. 406/19.
- 1.6.4 The Contractor shall be responsible for obtaining and submitting to the Construction Administrator at least fifteen (15) business days prior to removing excess soil from the Project Area, written consent from the owners and/or operators of the receiving sites, including an acknowledgement of receipt of any applicable analytical results, in accordance with O.Reg. 406/19 and in a format acceptable to the Contract Administrator. Under no circumstances should excess soil leave the Project Area prior to the finalization and acceptance of the necessary planning documents, site registration on the on-line Registry, or provision of an appropriate written consent from the owners and/or operators of the receiving sites.
- 1.6.5 Incorporate all costs associated with sampling, analysis, reporting, tracking, hauling, and management of excess soil and on-site soil materials.
- 1.6.6 Develop, implement, and apply a tracking system, in accordance with O.Reg.406/19 and the Soil Rules, to track each load of excess soil during its transportation and deposit at a reuse site, Class 1 soil management site, local waste transfer facility, or landfilling site.
- 1.6.7 Ensure that any person who is operating a vehicle for the purpose of transporting excess soil from the Project Area to recognized location as identified in the Excess Soil Destination Assessment Report is provided with an appropriate hauling record. All hauling records to be provided to the Construction Administrator upon request throughout the duration of the Project, and complete records shall be provided to the City upon conclusion of the Project.

## **2. PRODUCTS**

### **2.1 Backfill to Excavations**

- 2.1.1 Granular A and B shall conform to OPSS 1010. Sources for granular material shall come from an MTO designated aggregate sources list.
- 2.1.2 Clear stone shall conform to OPSS 1004.
- 2.1.3 Use suitable material from site excavations for site fills beyond the limits of excavations for structures. Use material that is inorganic, free from rocks larger than 150 mm, frozen material, debris, excessive water or other unsuitable material.

### **2.2 Engineered Fill**

- 2.2.1 Granular B shall conform to OPSS 1010.

**2.3     Concrete**

- 2.3.1     Concrete for encasing piping, mass concrete and mudslab shall be 15 MPa concrete as specified in Section 03300.
- 2.3.2     Unshrinkable fill for backfill between structure and shoring shall be 0.5 MPa.

**2.4     Filter Fabric**

- 2.4.1     Non-woven geotextile (Class 2, FOS 75 to 150 um) conforming to OPSS 1860.

**2.5     Compaction Equipment**

- 2.5.1     Utilize the type of compaction equipment used shall be suited to the material to be compacted, degree of compaction required, and space available.

**3.     EXECUTION**

**3.1     Excavation**

- 3.1.1     Comply with current Ontario Regulations for the management of excess soils.
- 3.1.2     Excavate below the bottom of foundations to the depths as shown on the drawings. Excavate clean, and level. Remove loose material.
- 3.1.3     Do not place granular or concrete before examination of the excavation and the acceptance of the Contract Administrator and Building Inspector has been obtained.
- 3.1.4     Construct each structure on stable ground, where structures at different elevations occur adjacent to each other.
- 3.1.5     Stockpile excavated materials required for use as fill or backfill so as not to interfere with construction. Do not place excavated material so as to cause pressure on newly placed structure(s), or pipe, or where it may cause soil slippage. Remove unwanted material, such as spoil or excess material from the site.
- 3.1.6     The material will require TCLP testing by Contractor prior to landfill disposal (and passing TCLP) to ensure the landfill's ability to accept. If disposed at the City landfill, there will be no tipping fees for deposition. If the material does not pass the TCLP test, the fill must be taken to an appropriate facility in accordance with the Regulation.
- 3.1.7     Where not otherwise specified, moisten as required, subgrade below foundations and slabs-on-grade, scarify and compact to 98 percent Standard Proctor Density before placing the foundations or slabs.

**3.2     Over-Excavation**

- 3.2.1     Refill over-excavation beneath structures where such over-excavation was not authorized by the Contract Administrator with 15 MPa concrete to the specified excavation level or as otherwise directed by the Contract Administrator. No payment will be made for such replacement.
- 3.2.2     Remove foundation material that has good bearing strength in its natural state and that has had its characteristics adversely changed by the Contractor's operations, and replace with 15 MPa fill concrete, or as otherwise directed by the Contract Administrator. No payment will be made for such removal and replacement.

- 3.2.3 When extra excavating is ordered by the Contract Administrator, the excavating Work as ordered by the Contract Administrator will be paid for as an addition to the Contract.

### 3.3 **Trenching**

- 3.3.1 Dig the trench to the alignment and depth required and only so far in advance of pipe laying as the governing standards will permit.
- 3.3.2 Minimum and maximum trench widths up to a point 0.3 m above top of pipe, for single pipe (excluding an allowance for shoring):

Minimum trench widths	greater of <ul style="list-style-type: none"> <li>0.75 m or</li> <li>outside diameter of pipe, plus 0.3 m either side of pipe.</li> </ul>	All pipe diameters
Maximum trench widths	greater of <ul style="list-style-type: none"> <li>0.75 m or</li> <li>outside diameter of pipe, plus 0.4 m either side of pipe.</li> </ul>	Pipe diameter < 850 mm
	outside diameter of pipe, plus 0.6 m either side of pipe.	Pipe diameter > 850 mm

- 3.3.3 The width of the trench at structure subgrade level is not to be less than the width at any depth in the trench. Fill overbreak and slides that have occurred during excavation with suitable materials.
- 3.3.4 Where trench excavations are not kept within the design limits of the pipe, the Contract Administrator may order sheathing and shoring, and/or a heavier class of pipe, and/or use of a higher class of bedding, at no cost to the owner.
- 3.3.5 Grade and shape the pipe trench and the specified bedding to give uniform and even bearing for the length of the pipe. Dig bell holes at each joint. Make corrections in the grade with compacted granular material acceptable to the Contract Administrator, or with fill concrete.

### 3.4 **Pipe Bedding and Backfill**

- 3.4.1 Do not place bedding on frozen or unconsolidated ground.
- 3.4.2 Concrete encase pipes, conduit, cable, or ducts in trenches located beneath structures, to the elevation of the subgrade.
- 3.4.3 Where granulars are specified, hand place, tamp and thoroughly consolidate bedding. Carefully bed pipes to ensure uniform bedding of the pipe throughout its entire length.
- 3.4.4 For pipe penetrating through a structure wall:
- .1 Locate the first joint not less than 0.6 m from the wall face
  - .2 Bed pipe with a 15 MPa concrete cradle (0.3 m below the pipe invert to one quarter the pipe diameter above the invert). Bed pipe (above the concrete cradle) with Granular A or 19 mm crushed stone
  - .3 Beyond the first joint, bed as specified elsewhere for pipes in trenches

- 3.4.5 Other pipes around the structure (including conduits, ducts and cables):
  - .1 Use a 100 mm surround of sand for bedding of conduits ducts and cable.
  - .2 Bed pipe with Granular A or 19 mm crushed stone.

### 3.5 **Fill and Backfill**

- 3.5.1 Extent of Materials
  - .1 Use 15 MPa concrete as specified above for pipes and as indicated on the contract drawings.
  - .2 Use Granular 'B' backfill to structures to a width equal to one-half the depth to the bottom of the structure (min. 600 mm at base) up to 300 mm below final rough grade.
  - .3 Use site selected excavated material or suitable non-organic imported material for fill and backfill beyond the limits for the granular material.
  - .4 Use selected site material (silt or clay) for top 300 mm below rough grade to provide a water seal for the granular backfill.
- 3.5.2 Where material specifications conflict use the highest density material.
- 3.5.3 Dewater subgrade to 0.3 m below excavated level or greater to achieve desired compaction.
- 3.5.4 Do not place fill or backfill on frozen ground or topsoil.
- 3.5.5 Where foundation walls are filled on both sides, place backfill evenly on both sides of the wall so as to avoid unequal pressures.
- 3.5.6 Shore and support structures that may be likely to be disturbed by compaction equipment.
- 3.5.7 Carefully place backfilling around piping and conduits so as to not displace nor damage the piping and conduits and take particular care to ensure the backfill under pipes and conduits leaving underground structures is thoroughly compacted, so no settlement can take place.
- 3.5.8 Bench or step the surface slopes where fill is to be placed to sloped surfaces.
- 3.5.9 Place backfill, fill and bedding materials in maximum lift thickness and to minimum densities listed:
  - .1 Footing, Foundation Slab, or Structure Influence Zones: maximum lift thickness of 150 mm and compaction to 100% Standard Proctor Density Test at optimum moisture content.
  - .2 Other: maximum lift thickness of 200 mm and compaction to 98% modified Standard Proctor Density.

### 3.6 **Compaction Tests**

- 3.6.1 Where compaction of sub-grade, backfill or fill is specified, the Contract Administrator may order compaction tests by an independent testing company. Tests will be arranged and paid by the Contract Administrator.
  - .1 If the compacting Work does not meet the specified requirement, perform further compacting Work until the specified requirement is met and pay the cost of further testing to establish proof of the specified compaction.

- .2 For fill or backfill compaction, tests will be made at every 450 mm depth (after three 150 mm lifts have been placed).
- .3 Co-operate with the Contract Administrator and testing company by scheduling the placing and compacting of fill and backfill so tests can be progressively taken.

**3.7 Rough Grading**

- 3.7.1 Rough grade, compact and grade the site, in accordance with the Drawings, to within a tolerance of 50 mm, to receive finish grading. Remove soft areas in the subgrade and replace with suitable material as directed by the Engineer. Provide additional suitable material if necessary.
- 3.7.2 Grade and maintain rough grades, including slopes and ditches, to provide proper drainage.

**END OF SECTION**

**1. GENERAL**

**1.1 References**

- 1.1.1 American Society for Testing and Materials (ASTM)
  - .1 ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/mn).
- 1.1.2 Conform to City of Welland Municipal Standards

**1.2 Existing Conditions**

- 1.2.1 The Contractor accepts responsibility for subsurface conditions. Refer to the relevant Geotechnical Reports attached to the specifications.
- 1.2.2 The Contractor is to establish the exact location of all surface and buried objects whether shown on the contract drawings or not.
- 1.2.3 Refer to dewatering in Section 31 23 19 – Dewatering.

**1.3 Protection**

- 1.3.1 Protect and/or transplant existing fencing, trees, landscaping, natural features, benchmarks, buildings, pavement, surface or underground utility lines which are to remain as directed by the Engineer. If damaged, contractor to restore to original or better condition at no additional cost to the Owner.
- 1.3.2 Employ the services of an approved arborist where grading will disturb root systems of trees that are to remain. Cut and treat root systems as required prior to grading. Appropriate tree protection measures as required in accordance with the Tree Protection Plan (provided in contract documents) and per City of Brantford's standards.
- 1.3.3 Appropriate erosion and sediment controls shall be implemented in accordance with the Owner's and MECP standards, and per Section 31 25 00.

**1.4 Payment**

- 1.4.1 Work outlined in this section is included in the lump sum tender price.
- 1.4.2 The lump sum payment will include grading work as shown on the drawings. No extra will be accepted for imported fill material for the grading.

**2. PRODUCTS**

**2.1 Materials**

- 2.1.1 Excavated or graded material existing on site may be suitable to use as fill for grading work, only when approved by the Engineer. Contractor may be required to submit supplemental geotechnical recommendations in support of on-site reuse.



3. **EXECUTION**

3.1 **Stripping of Topsoil**

- 3.1.1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected as determined by the Engineer.
- 3.1.2 Commence topsoil stripping as required after area has been cleared.
- 3.1.3 Stockpile in locations as approved by the Engineer. Stockpile shall be surrounded by silt fence.
- 3.1.4 Dispose of unused topsoil off site.

3.2 **Rough Grading**

- 3.2.1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated on the Contract Drawings.
- 3.2.2 Slope rough grade away from building 1:50 (2%) minimum in vegetated areas and 1% minimum in paved areas.
- 3.2.3 Compact filled and disturbed areas to 95 per cent Standard Proctor Maximum Dry Density (SPMDD) to ASTM D 698.
- 3.2.4 Do not disturb soil within branch spread of trees or shrubs that are to remain.
- 3.2.5 Use selected excavated material to rough grade the site. Make up any shortfall in selected excavated material with imported fill material. Place fill in lifts of 300mm compacted to 95 percent SPMDD at a placement moisture content within two per cent of optimum.
- 3.2.6 Handle excavated material so that selected topsoil material is placed on top surface.
- 3.2.7 Raising or lowering of the grade to avoid haulage is not permitted.
- 3.2.8 Cut and fill to levels required for paved, sodded and landscaped areas. Make allowance for depth of finishes and base courses.
- 3.2.9 Establish and maintain line and grade stakes for duration of grading operations.
- 3.2.10 Conform to grades and contours indicated. Uniformly slope grade between elevations shown unless otherwise indicated.
- 3.2.11 Proof roll existing subgrade below paved areas after excavation with a heavy roller. Compact subsoil below paved areas to a minimum 95 per cent SPMDD. Sub-excavate loose, soft and excessively wet areas and areas containing organic material, and fill with suitable fill capable of being compacted to required density.

- 3.2.12 Establish subgrade parallel to the finished grades indicated and shape in such a manner to permit drainage. Shape subgrade below paved areas to drain to perimeter drains or catchbasins.
- 3.2.13 Fill, where required, in accordance with requirements for backfilling specified hereinbefore.
- 3.2.14 Rough grade areas to a tolerance of  $\pm 50\text{mm}$ .

### **3.3 Final Grading**

- 3.3.1 Final grading and landscaping are to be completed in accordance with the Contract Drawings.
- 3.3.2 Remove stones or rock fragments larger than 50mm nominal diameter from the top of finished grade.
- 3.3.3 Make adjustments in lines or grades as necessary in order to obtain satisfactory construction.
- 3.3.4 Smoothly slope top and toe of slopes and banks.

### **3.4 Testing**

- 3.4.1 Inspection and testing of soil compaction will be carried out by the Engineer. Costs of tests will be paid by the Owner.

### **3.5 Surplus Material**

- 3.5.1 Remove surplus material and material unsuitable for fill, grading or landscaping off site as directed by the Engineer.

**END OF SECTION**

**1. GENERAL**

**1.1 Intent**

- 1.1.1 This Section covers the Work to maintain dry working conditions for the construction of the facility and stabilize excavation subgrade soils for general construction.
- 1.1.2 The Contractor is directed to the Geotechnical Investigation, Proposed Single Story Institutional Building, 5 Lincoln Street, Welland, Ontario, Dated October 26, 2022, for all dewatering recommendations.
- 1.1.3 Work included is as follows:
  - .1 The Contractor shall include costs to dewater all excavations in accordance with local, regional, and provincial standards and regulations.
  - .2 The Contractor shall manage site drainage to prevent surface runoff from entering the excavation during construction.
  - .3 Safely dispose discharge water.
  - .4 Monitor ground movements and discharge flows.

**1.2 Standards**

- 1.2.1 Comply with the latest versions of:
  - .1 Provincial regulations, as applicable
  - .2 The latest City of Welland Municipal Standards.
  - .3 The City of Welland Works Discharge Permit (SWDP), including all reporting and sampling requirements.
- 1.2.2 Reference document
  - .1 Geotechnical Investigation, Proposed Single Story Story Institutional Building, 5 Lincoln Street, Welland, Ontario, Niagara Testing & Inspection Ltd., October 26, 2022.
- 1.2.3 Related Work
  - .1 31 10 00 - Site Clearing, Excavating, Backfilling and Grading for Structures
- 1.2.4 The following Geotechnical Reports are available for review and appended to this specification.
  - .1 As noted in 1.2.2 above.
- 1.2.5 The Contractor shall assume full responsibility for interpretation of all available soil and groundwater information, planning and execution of the dewatering work.
- 1.2.6 Claims arising from the interpretation of available information will not be considered.

**1.3 Environmental Compliance**

- 1.3.1 Comply with all Ontario Provincial Regulations and other approving agencies related to water taking for construction dewatering including Environmental Activity and Sector Registry.

**1.4 Submission Requirements**

- 1.4.1 Qualifications of the Contractor (or Subcontractor) undertaking the work, including years of experience and list of at least five (5) projects of similar size.
- 1.4.2 Prepare and submit working drawings and design notes for the proposed dewatering systems, two (2) weeks prior to commencing system installation. Indicate how surface water runoff and accumulated precipitation will be managed concurrently with operation of this system. The general plan shall include:
  - .1 Location, depth and details of the primary dewatering system.
  - .2 Details, sizes, materials of pumps, discharge lines, etc including power requirements.
  - .3 Location of generators and other noise producing equipment, and anticipated decibel levels if requested.
  - .4 Relationship between dewatering equipment, existing structures and the excavation management plan.
  - .5 Location of dewatering discharge points.
  - .6 Details of screens, filters and other water treatment equipment (as applicable).
  - .7 Location and depth of existing and proposed groundwater observation wells.
  - .8 Location of monitoring points, including water level and flow measurement.
  - .9 Backup power contingency plan for primary system in the event of power failure.
  - .10 Maintenance requirements / plans.
  - .11 System removal and decommissioning plan.
  - .12 Include signature and seal of the Professional Engineer responsible for design.
  - .13 Individual responsible for the supervision of the dewatering system including 24 hour contact information.
- 1.4.3 The submissions will be reviewed for conformance to this specification and will not be reviewed for adequacy of the system.
- 1.4.4 Groundwater Discharge:
  - .1 Provide a calibrated totalizing flow meter to record dewatering rates. Record flow data daily.

## **2. PRODUCTS**

### **2.1 Dewatering Equipment**

- 2.1.1 All pipes, wells, vacuum well points, well-points, connections, sealant, pumps, fittings, hoses, gauges, valves, electrical generators and other equipment as required to dewater in accordance with the requirements of this section.
- 2.1.2 Provide a valved header system to isolate wells on opposing sides of the excavation, for the purposes of testing effectiveness.
- 2.1.3 Standby pumps, generator and auxiliary dewatering equipment in the event of breakdown with effective muffling devices to keep noise levels to levels specified.

2.2 **Other Equipment**

- 2.2.1 Provide screens and filters, temporary pipes, hoses, flumes, or channels for the transport of discharge water to the discharge location.
- 2.2.2 Provide all other equipment to suit the design.

3. **EXECUTION**

- 3.1.1 Obtain all approvals and permits as required.

**END OF SECTION**

1. **GENERAL**

1.1 **Conformance**

1.1.1 Erosion and sediment controls shall be designed, constructed and maintained in accordance with

.1 The most recent requirements of the City of Welland Municipal Standards.

Ontario Provincial Standard Specifications, Volume 7 – Municipal Construction Specifications

1.2 **Measurement and Payment**

1.2.1 All costs for items and works outlined in this section are to be included in the total lump sum tender price.

2. **PRODUCTS**

2.1 **Equipment**

2.1.1 Controls which shall be incorporated on site to trap and control sediment and erosion include: sediment control fence, catch basin sediment barrier, gravel sandbags, and river stone erosion control.

3. **EXECUTION**

3.1 **Sediment Control Fencing**

3.1.1 Install all sediment control fence to the satisfaction of the Engineer. All sediment control fences must be erected along the perimeter of construction site prior to the commencement of any site grading operations, and the Engineer should be notified for appointment of appropriate erection locations for the sediment control fencing.

3.1.2 Ensure that filter fabric is securely anchored to fencing and buried in trenching. Overlap joints in filter fabric minimum 1000mm. Do not trench in areas of tree roots.

3.1.3 Place clear granular fill on grade as directed by the Engineer.

3.1.4 Maintain and repair sediment control fence during construction as required. Remove or relocate fence only upon approval of the Engineer.

3.1.5 Remove and dispose sediments when accumulation reaches to within 450mm of top of filter fabric.

3.2 **Catchbasin Sediment Barrier**

3.2.1 All existing catchbasins to have sediment barrier. All proposed catchbasins to have sediment barrier erected immediately after catchbasin installation.

- 3.2.2 Maintain sediment protection barrier on a regular basis to the satisfaction of the Engineer.

**3.3 Gravel Sandbags**

- 3.3.1 Install gravel sandbags between creek and outfall during construction.

**3.4 River Stone Erosion Control**

- 3.4.1 Install river stone erosion control at overflow pipe outfall as shown on drawings.

**3.5 Soil Stabilization**

- 3.5.1 If the site construction activities are interrupted and/or inactivity exceeds 30 days, all stripped and/or bare soil areas are to be stabilized by sodding, seeding, and mulching or other approved method to the satisfaction of the Engineer.

**3.6 Mud-Tracking Control**

- 3.6.1 Maintain all public roadways in clean condition, free of dirt and mud. Flush and sweep roads as warranted for mud-tracking control to the satisfaction of the Engineer and Owner.
- 3.6.2 Upon 24 hour notice, the Owner will retain street sweeper and charge Contractor if road cleaning efforts are inadequate.

**END OF SECTION**

**1. GENERAL**

**1.1 Intent of Section**

- 1.1.1 Section includes the construction of granular base and sub-base for roadways, driveways, and parking lots.

**1.2 Measurement and Payment**

- 1.2.1 Work outlined in this section is included in the lump sum tender price.

**1.3 References**

- 1.3.1 ASTM C 117, Test Method for Material Finer Than 0.075mm Sieve in Mineral Aggregates by Washing.
- 1.3.2 ASTM C 131, Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- 1.3.3 ASTM C 136, Method for Sieve Analysis for Fine and Coarse Aggregates.
- 1.3.4 ASTM D 698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>)(2,700 kN-m/m<sup>3</sup>).
- 1.3.5 ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>)(2,700 kN-m/m<sup>3</sup>).
- 1.3.6 ASTM D 1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
- 1.3.7 ASTM D 4318, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- 1.3.8 CAN/CGSB-8.1, Sieves Testing, Woven Wire, Inch Series.
- 1.3.9 CAN/CGSB-8.2, Sieves Testing, Woven Wire, Metric.
- 1.3.10 City of Brantford Design and Construction Manual, Latest version
- 1.3.11 Ontario Provincial Standard Specifications, Volume 7 - Municipal Construction Specifications

**1.4 Delivery, Storage and Handling**

- 1.4.1 Delivery and stockpile aggregates in accordance with Section 31 05 16 – Aggregates. Stockpile minimum 50 per cent of total aggregate required prior to commencing operation.
- 1.4.2 Store cement in weather tight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.



## 2. PRODUCTS

### 2.1 Materials

2.1.1 For Granular base and Granular Sub-Base materials to Section 31 05 16 – Aggregates and following requirements:

.1 Gradations to be within limits specified when tested to ASTM C1 136 and ASTM 117. Sieve sizes to CAN/CGSB-8.1.

2.1.2 Other Properties as follows:

.1 Liquid limit: to ASTM D 4318, maximum 25

.2 Plasticity index: to ASTM D 4318, maximum 6

.3 Crushed particles: at least 60 per cent of particles by mass within each of the following sieve designation ranges to have at least one freshly fractured face. Material to be divided into ranges using methods of ASTM C 136.

2.1.3 Soaked CBR: to ASTM D 1883, min 80, when compacted to 100 per cent of ASTM D 1557.

## 3. EXECUTION

### 3.1 Sequence of Operation

3.1.1 Place granular base after the sub-base surface is inspected and approved by the Engineer / Consultant.

3.1.2 Placing of Granular Base (refer to Section 3.2)

3.1.3 Compacting (refer to Section 3.3)

3.1.4 Proof Rolling (refer to Section 3.4)

### 3.2 Placing

3.2.1 Place granular sub-base after sub-grade is inspected and approved by the Engineer / Consultant.

3.2.2 Construct granular sub-base to depths and grade in areas indicated.

3.2.3 Ensure no frozen material is placed.

3.2.4 Place material only on clean unfrozen surface, free from snow or ice.

3.2.5 Place granular sub-base materials using methods which do not lead to segregation or degradation.

3.2.6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.

- 3.2.7 Place material to full width in uniform layers not exceeding 150mm compacted thickness.
- 3.2.8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- 3.2.9 Remove and replace portion of layer in which material has become segregated or unsuitable during spreading.

### **3.3     Compaction**

- 3.3.1 Compaction equipment to be capable of obtaining required material densities.
- 3.3.2 Compact to density of not less than 98 per cent Standard Proctor Maximum Dry Density (SPMDD) in accordance with ASTM D 698.
- 3.3.3 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.
- 3.3.4 Apply water as necessary during compaction to obtain specified density.
- 3.3.5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by the Engineer / Consultant.
- 3.3.6 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

### **3.4     Proof Rolling**

- 3.4.1 Proof rolling shall be used in pavement areas.
- 3.4.2 For proof rolling use standard roller of 45,400kg gross mass with four pneumatic tires each carrying 11,350kg and inflated to 620kPa. Four tires arranged abreast with centre to centre spacing of 730mm maximum.
- 3.4.3 Obtain approval from the Engineer / Consultant to use non standard proof rolling equipment.
- 3.4.4 Proof roll at level in sub-base as indicated. If non standard proof rolling equipment is approved, the Engineer / Consultant is to determine level of proof rolling.
- 3.4.5 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- 3.4.6 Where proof rolling reveals areas of defective subgrade:
  - .1 Remove sub-base and subgrade material to depth and extent as directed by the Engineer / Consultant.
  - .2 Backfill excavated subgrade with approved common material and compact in accordance with this section.

- 3.4.7 If proof rolling is carried out on the granular sub-base, if it reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.

### **3.5 Site Tolerances**

- 3.5.1 Finished base and sub-base surface to be within plus or minus 5mm of established grade and cross section but not uniformly high or low.

### **3.6 Protection**

- 3.6.1 Maintain finished base and sub-base in condition conforming to this section until succeeding material is applied or until acceptance by the Engineer / Consultant.

**END OF SECTION**

1 General

1.1 SUMMARY

- .1 Supply and installation of asphalt pavement structures and pavement line markings.
- .2 Subgrade preparation and placement of granular base are addressed in Section 31 23 33.

1.2 RELATED REQUIREMENTS

- .1 Section 31 23 33: Excavation, Trenching and Backfilling
- .2 Section 32 16 26: Concrete curbs and sidewalks

1.3 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM):
  - .1 ASTM D242-09, Standard Specification for Mineral Filler for Bituminous Paving Mixtures
  - .2 ASTM D692/D692M-09, Standard Specification for Course Aggregate for Bituminous Paving Mixtures
  - .3 ASTM D946/D946-09a, Standard Specification for Penetration Graded Asphalt Cement for Use in Pavement Construction
  - .4 ASTM D979/D979M-12, Standard Practice for Sampling Bituminous Paving Mixtures
  - .5 ASTM D995-95b(2002), Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
  - .6 ASTM D1073-11, Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
  - .7 ASTM D5581-07ae1, Standard Test Method for Resistance To Plastic Flow Of Bituminous Mixtures Using Marshall Apparatus (6 inch-Diameter Specimen)
  - .8 ASTM D2027/D2027M-10, Standard Specification for Cutback Asphalt (Medium-Curing Type)
  - .9 ASTM D3515-01, Standard Specification for Hot-Mixed, Hot -Laid Bituminous Paving Mixtures
- .2 Asphalt Institute:
  - .1 Asphalt Institute IS-91, Full-Depth Asphalt Pavements for Parking Lots, Service Stations and Driveways.
  - .2 Asphalt Institute MS-4, The Asphalt Handbook.
  - .3 Asphalt Institute SS-1, Model Construction Specifications for Asphalt Concrete.
- .3 Canadian General Standards Board (CGSB):
  - .1 CAN/CGSB-8.2-M88, Sieves Testing, Woven Wire, Metric.
  - .2 CAN/CGSB-16.1-M89, Cutback Asphalts for Road Purposes.
  - .3 CAN/CGSB-16.2-M89, Emulsified Asphalts, Anionic Type, for Road Purposes.
  - .4 CAN/CGSB-16.3-M90, Asphalt Cements for Road Purposes.
  - .5 CAN/CGSB 1.5-M-91, Low Flash Petroleum Spirits Thinner.
  - .6 CGSB-1.74-2001, Alkyd Traffic Paint.

1.4 QUALIFICATIONS

- .1 Asphalt concrete mixing plants shall conform to ASTM D995.

- .2 Provide the equipment, materials, and labour to complete the job. Variations in the size and amount of equipment will depend on the size of the area being paved.

#### 1.5 BASIS OF PAYMENT

- .1 Payment will be on a stipulated price payment that includes for furnishing, hauling and placement of materials, for rolling, compaction and labour, and use of equipment, tools and incidentals necessary to complete the work of this section. Report immediately site conditions that differ significantly from those anticipated. Consultant will provide clarification or request a change to the work for an adjustment to the contract price.

#### 1.6 SUBMITTALS

- .1 Provide required product information in accordance with Section 01 33 00.
- .2 Submit asphalt concrete mix design and list of equipment and materials proposed for use to Consultant for review.
- .3 Submit a certificate of compliance indicating that the asphalt meets the requirements of the specifications, standards listed above and good local construction practices.

#### 1.7 TESTING

- .1 Materials shall be tested by accredited testing laboratory and included in Bid Price.
- .2 Sampling will follow recommended practice of ASTM D979.
- .3 Submit test certificates showing suitability of materials at least 4 weeks prior to commencing work.

#### 1.8 WARRANTY

- .1 Provide a materials and workmanship bond for an additional period of three (3) years taking effect after one year warranty required by CCDC 2. Bond shall cover defects in material and workmanship affecting the appearance and long term performance of the completed installation.

### 2 Products

#### 2.1 HOT-MIX, HOT-LAID ASPHALT

- .1 Design and prepare plant hot-mixed, hot-laid pavement mixtures utilizing asphalt cement and aggregate in accordance with ASTM D3515 and the following requirements.

#### 2.2 BITUMINOUS MATERIALS

- .1 Asphalt Cement:
  - .1 Parking Areas: Penetration grade of 200 to 300 in accordance with to ASTM D946.
  - .2 Aggregates shall be coated with a minimum film thickness of 6.5 µm in accordance with Marshall Mix Design Criteria and requirements of ASTM D5581.
- .2 Tack Coat: Emulsified anionic asphalt, SS-1 or SS-1h mixed with water and meeting the requirements of ASTM D977.
- .3 Primer Coat: medium curing, medium viscosity cutback asphalt, MC-80 meeting the requirements of AASHTO M82 and ASTM D2027.

#### 2.3 MINERAL AGGREGATE

- .1 Mineral aggregate for asphalt plant-mix shall consist of crushed stone, crushed gravel, sand, mineral filler, to ASTM D692 and ASTM D1073 and mineral filler. Mineral filler may be Portland cement, pozzolan, or commercially ground stone dust conforming to ASTM D242, and as follows:
  - .1 Coarse aggregate shall be sound, angular crushed stone, crushed gravel, or crushed slag. Uncrushed coarse aggregate may be used in base course mixtures if the mixture

meets all design criteria. The fine aggregate shall be well graded, moderately sharp to sharp sands.

- .2 Mineral aggregate and asphalt shall be combined in a mixing plant to meet the following nominal gradations for asphalt concrete:

Base and Surface Asphalt for new paving

<u>Sieve Size</u>	<u>% Passing by Weight</u>	
3/4"	100	
3/8"	60-80	
#4	40-65	
#8	30-50	
#30	15-30	100
#50	10-25	95-100
#100	5-20	
#200	3-8	70-100

Asphalt content as a percentage of weight by total mix shall conform to the requirements of Asphalt Institute MS-4.

## 2.4 ACCESSORIES

- .1 Line Paint:
  - .1 To CGSB 1-GP-74M, alkyd traffic paint; colour, yellow, and as indicated on Drawings.
  - .2 Thinner: To CAN/CGSB-1.5.
- .2 Cast-in-place Concrete Curbs:
  - .1 Concrete ingredients, admixtures and reinforcing steel to CSA A23.4.
  - .2 Anchors: Smooth 10mm (3/8") dia reinforcing bars, pointed at one end, minimum length to penetrate 457mm (18") through asphalt and subgrade.
  - .3 Finish and colour of precast concrete, standard gray, as indicated in Section 32 16 26.
- .3 Adjustment Rims: as required to adjust elevation of manhole rims and valve chambers.

## 3 Execution

### 3.1 PREPARATION

- .1 Grades and elevations shall be established by the Contractor, and as follows:
  - .1 The Contractor shall set grade stakes to the correct elevation.
  - .2 Coordinate grades with existing features and adjoining properties to ensure proper drainage.
- .2 Remove all debris, vegetation, and other deleterious materials from the site, except for trees or shrubs designated for preservation.
- .3 Grade site in accordance with required profiles and remove excess material removed from site.
- .4 Compact subgrade at the lowest moisture content such that firm closing of hand can mould a handful of soil:
  - .1 Surface of subgrade after compaction shall be hard, uniform, smooth, and true to grade and cross-section. Confirm compaction by driving a heavily loaded truck over subgrade and verify that minimal deflection occurred.

- .2 Roll subgrade to correct conditions where significant deflection occurs.
- .3 Scarify subgrade to a depth of 150mm (6") and recompact where rolling does not correct the soft condition.
- .4 Remove and replace subgrade with select materials where re-compaction does not correct soft condition.
- .5 Treat subgrade with a soil sterilant at the rate specified by the manufacturer to prevent the growth of weeds prior to placing base courses.
- .6 Prepare granular base courses in accordance with Section 31 23 33.
- .7 Apply cutback asphalt prime coat to prepared granular base courses at a minimum rate of 0.7 L/m<sup>2</sup> (0.15 gal/yd<sup>2</sup>).

### 3.2 PAVEMENT CONSTRUCTION

- .1 Heavy Traffic Construction: Lay plant hot-mixed, hot laid asphalt base and surface courses to a total thickness of 105mm (4"). In weather colder than 5 deg C (40 deg F), each material course shall be laid in a single lift.
  - .1 HL 8 base course asphalt shall be laid to a compacted thickness of 65mm (2.5").
  - .2 HL3 surface course asphalt shall be laid to a compacted thickness of 40mm (1.5").
- .2 Light Traffic Construction: Lay plant hot-mixed, hot laid asphalt base and surface courses to a total thickness of 90mm (3.54"), unless otherwise indicated on Drawings. In weather colder than 5 deg C (40 deg F), each material course shall be laid in a single lift.
  - .1 HL8 base course asphalt shall be laid to a compacted thickness of 50mm (2").
  - .2 HL3 surface course asphalt shall be laid to a compacted thickness of 40mm (1.5").
- .3 Spreading Base and Surface Courses:
  - .1 For areas greater than 840 m<sup>2</sup> (1,000 yd<sup>2</sup>):
    - .1 Asphalt base and surface courses shall be spread and struck off with a paver.
    - .2 Any irregularities in the surface of the pavement course shall be corrected directly behind the paver.
    - .3 Excess material forming high spots shall be removed with a shovel or a lute.
    - .4 Indented areas shall be filled with hot mix and smoothed with a lute or the edge of a shovel being pulled over the surface.
    - .5 Casting of mix over such areas shall not be permitted.
    - .6 For areas less than 840 m<sup>2</sup> (1,000 yd<sup>2</sup>) and in areas where it is not practical to use a paver or spreader box:
      - .7 Spread asphalt base and finish surface courses by hand.
      - .8 Use rigidly supported wood or steel forms to ensure correct grade and cross-section
      - .9 Placing by hand shall be performed carefully to avoid segregation of the mix.
      - .10 Broadcasting of the material will not be permitted.
      - .11 Any lumps that do not break down readily shall be removed.
- .4 Roll and compact hot-mix material immediately without displacement; continue rolling until thoroughly compacted and all roller marks have disappeared.
- .5 In areas too small for the roller, a vibrating plate compactor or hand tamper shall be used to achieve thorough compaction.

- .6 The surface of the completed work shall be level to 6mm in 3048mm (1/4" in 10") when tested with a straightedge. Surface shall not contain irregularities that affect drainage, create puddles created than 2 ft<sup>2</sup>.

### **3.3 APPLICATION OF PAVEMENT LINE MARKINGS**

- .1 Clean pavement surface in accordance with paint manufacturers written instructions.
- .2 Paint lines straight and in uniform width, at locations indicated on drawings.
- .3 Apply paint using marking machine or line stencil, and as recommended by manufacturer, to minimum 0.18mm (0.007") dry film thickness.
- .4 Line Width: Roadways and Parking Areas: As indicated on Drawings.

### **3.4 CLEANING**

- .1 Remove spillage and over-spray of paint from pavement, sidewalks, building and other site features. Use methods and materials without damaging and leaving visible residue on substrates.

### **3.5 PROTECTION OF COMPLETED WORK**

- .1 Keep traffic off pavement markings for a time as recommended by paint manufacturer.

**END OF SECTION**



1 General

1.1 SUMMARY

- .1 Supply and installation of concrete and to form curbs and sidewalks, as indicated in this Section.

1.2 RELATED REQUIREMENTS

- .1 Section 03 30 00: Cast-In-Place Concrete  
.2 Section 03 35 00: Concrete Finishing  
.3 Section 31 23 33: Excavation, Trenching and Backfilling  
.4 Section 32 12 16: Asphalt Paving for Parking Lots and Driveways

1.3 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM)  
.1 ASTM C309-11, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete  
.2 ASTM D1751-04(2008), Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)  
.3 ASTM D1752-04a(2008): Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction  
.2 Canadian Standards Association (CSA)  
.1 CSA A23.1-09/23.2-09: Concrete Materials and Methods of Concrete Construction/Test methods and Standard Practices for Concrete  
.2 CSA G30.18-09: Carbon Steel Bars for Concrete Reinforcement  
.3 CAN/CSA B651-04(R2010): Accessible Design for the Built Environment

2 Products

2.1 MATERIALS

- .1 Granular Base:  
.1 Conforming to OPSS Form No. 1010, Class 'A' aggregate:

Sieve Designation	% Passing by Dry Weight
Imperial	
22mm (7/8")	100
16mm (5/8")	75 - 100
13mm (1/2")	65 - 90
No. 4	35 - 55
No. 16	15 - 45
No. 50	5 - 22
No. 200	0 - 8

- .2 Forms:
  - .1 Form Materials: Plywood, metal, metal framed plywood, or other acceptable panel type materials to provide full depth, continuous, straight, smooth exposed surfaces.
  - .2 Use flexible or curved forms for curves with a radius of 30m or less.
  - .3 Form Release Agent: Commercially formulated form release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- .3 Steel Reinforcement:
  - .1 Plain Steel Welded Wire Reinforcement: Meeting the requirements of ASTM A185, fabricated from as-drawn steel wire into flat sheets.
  - .2 Deformed Steel Welded Wire Reinforcement: Meeting the requirements of ASTM A497, flat sheet.
  - .3 Reinforcing Bars: Deformed bars, meeting requirements of CSA G30.18, and Grade meeting requirements of Structural Engineer. Dowels and Tie-Bars: Smooth or deformed bars, meeting requirements of CSA G30.18, Grade meeting requirements of Structural Engineer, and as follows:
    - .1 Dowels:
      - .1 Plain round bars, clean, straight and free from flattened or burred ends.
      - .2 Dowels for contraction joints shall be in rigid assemblies of required dimension and spacing and held in the middle of the slab depth to proper horizontal and vertical alignment.
    - .2 Tie-Bars: Deformed steel bars.
  - .4 Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place, fabricated from steel wire, plastic, or precast concrete of greater compressive strength than concrete; equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
- .4 Concrete Materials:
  - .1 Hydraulic Cement Type: Normal, grey Portland Cement in accordance with CSA A3000, Type GU.
  - .2 Concrete Admixtures: Certified by manufacturer to contain a maximum of 0.1% water-soluble chloride ions by mass of cementitious material and being compatible with other admixtures and cementitious materials; do not use admixtures containing calcium chloride:
    - .1 Corrosion Inhibiting Admixture:
      - .1 Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
      - .2 Acceptable materials: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
        - .1 FerroGard-901; Sika Corporation.
        - .2 DCI or DCI-S; Grace Construction Materials.
        - .3 Rheocrete 222+; BASF

- .5 Water: Meeting requirements of CSA A23.1/A23.2.
- .6 Concrete Aggregate: Meeting requirements of CSA A23.1/A23.2, containing no shale, and as follows:
  - .1 Normal Density Fine Aggregate: Nominal maximum aggregate size in accordance with CSA A23.2-1A, uniformly graded to maintain Workability and control water bleed out, as indicated on Drawings.
  - .2 Normal Density Coarse Aggregate: Aggregate selected from Group I or Group II Grading Classifications, to suit design mix, in accordance with CSA A23.2-13A, nominal maximum aggregate sizes and applications as indicated on Drawings.
- .7 Expansion and Isolation Joint Filler Strips: Meeting requirements of ASTM D1751, asphalt saturated cellulose fibre.
- .8 Curing Materials:
  - .1 Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 300 g/m<sup>2</sup> dry weight.
  - .2 Moisture Retaining Cover: ASTM C171, polyethylene film or white burlap polyethylene sheet.
  - .3 Water: Potable.
  - .4 Curing and Sealing Compound: Ultra-violet light resistant, non-yellowing acrylic polymer/water based type curing and sealing compound conforming to ASTM C309-93, Type 1, Class B, 'Sealtight VOCOMP-20' by W.R. Meadows of Canada Limited, or 'Florseal W.B.' by Sika Canada Inc., or approved equal.

### 3 Execution

#### 3.1 PREPARATION

- .1 Set out work from lines and levels shown on drawings.
- .2 Fine grade, shape and compact subgrade to minimum of 98% Standard Proctor Density.

#### 3.2 INSTALLATION

- .1 Concrete Curbs:
  - .1 Align concrete curbs with curves and tangents as shown on drawings. The minimum overall depth shall be 457mm (18") with a curb face of 150mm (6") as shown on drawings.
  - .2 Obtain approval of forms from Consultant before pouring concrete.
  - .3 Side forms shall be of nominal 50mm (2") thick lumber, free of warp, and properly supported to maintain alignment and grade, except on curved sections where nominal 25mm (1") lumber may be used. Treat all form lumber with a non-staining mineral oil prior to concrete placement. Construct form to prevent honeycombing.
  - .4 Curbs shall have expansion joints of asphalt plank at 4572mm to 6096mm (15' to 20') intervals. Place a reinforcing bar at top and base of curb, with concrete coverage of 50mm (2") minimum.
- .2 Sidewalks:
  - .1 Place granular base immediately after the subgrade is approved by the Consultant, to 150mm (6") compacted thickness.
  - .2 Fine grade, shape and compact each layer to a minimum of 98% Standard Proctor Density.

- .3 Maintain true grade and cross section for each layer of material.
- .4 Place asphalt planks to form expansion joints at maximum of 4572mm to 6096mm (15' to 20') intervals with dummy joints at 1524mm (5') O/C.
- .5 Place welded wire mesh 38mm (1-1/2") from top surface of concrete. Lap mesh mats 150mm (6") and tie securely.
- .3 Concrete:
  - .1 Pour concrete on prepared granular base to required levels and dimensions. Execute work in accordance with CAN/CSA-A23.1/A23.2.
  - .2 Do not deposit concrete on frozen ground. When deposited in forms concrete shall have a temperature between 10 deg.C and 30 deg.C and these limits shall be maintained for 72 hours.
  - .3 Fill forms with an excess of concrete and, after compacting strike to the required level in such a manner as to force the coarse aggregate below the mortar surface; finish top surface with a wood float to an even, smooth, dense surface.
  - .4 Do not strip forms for 24 hours after pouring concrete.
  - .5 After finishing and after stripping the forms, treat surfaces with approved curing compound.
  - .6 By means acceptable to the Consultant protect concrete from harmful effects of sunshine, drying winds and cold running of surface water for a minimum period of 5 days.
- .4 Curbs Finishes:
  - .1 Curbs Finish edges of dummy joints and expansion joints with 6mm (1/4") radius edging tool.
  - .2 Sidewalks Concrete shall have a broom finish, employing a stiff broom, to produce an even, "non-slip" surface.
  - .3 Form intermediate dummy joints with a trowel cut. Edges of dummy joints and expansion joints shall be finished with a 6mm (1/4") radius edging tool.
  - .4 Provide concrete curb cuts and sidewalk handicap access ramps as indicated in accordance with CAN/CSA-B651 and the authorities having jurisdiction.

**END OF SECTION**

1 General

**1.1 SUMMARY**

- .1 This Section includes for the supply and installation of precast concrete wheel stops and anchors for installation at parking areas illustrated.

**1.2 RELATED REQUIREMENTS**

- .1 Section 32 12 16: Asphalt Paving for Parking Lots and Driveways
- .2 Section 32 14 40: Stone Paving

**1.3 REFERENCE STANDARDS**

- .1 CSA A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
- .2 CSA A3000-08, Cementitious Materials Compendium
- .3 CPCI Handbook.

**1.4 PERFORMANCE REQUIREMENTS**

- .1 Perform work in accordance with CSA A23.4, CSA A251, CPCI Handbook. Where requirements of one standard exceed another, the most restrictive requirement will govern.

**1.5 ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-Construction Conference: Arrange a site meeting attended by the Contractor, the Subcontractor, the Consultant, materials supplier(s), and other relevant personal before commencement of work for this Section; as indicated in Section 01 31 13 Project Meetings.

**1.6 SUBMITTALS**

- .1 Provide requested information in accordance with Section 01 33 00.
- .2 Action Submittals: Provide the following submittals before starting any work of this Section:
  - .1 Product Data: Submit manufacturers product data for each type of product specified.
  - .2 Shop Drawings: Submit shop drawings incorporating plans, elevations, sections and details for all work in this Section. The details shall illustrate and note all material thicknesses, types and finishes, and type of construction.
  - .3 Samples for Verification: Submit samples for verification for each type and colour of precast concrete parking bumper.

**1.7 DESIGN REQUIREMENTS**

- .1 Reinforce units to withstand handling stresses, temperature changes, loads and all other dead and live loads.

**1.8 QUALITY ASSURANCE**

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
  - .1 Supplier: Obtain precast units of a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer.

**1.9 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver precast architectural wheel stop concrete units to Project site in quantities and times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so markings are visible.

- .2 Units showing such defects will be replaced and made good together with all work of other trades damaged during removal of defective precast units at no expense to the Owner.

## 2 Products

### 2.1 MATERIALS

- .1 Hydraulic cement: To CAN/CSA-A3000, General Use - Type GU, grey.
- .2 Water: To CSA-A23.1/A23.2, clear potable.
- .3 Aggregates: To CSA-A23.1/A23.2, normal weight, containing no shale, with light steel grey-coloured aggregate, crushed to 10mm (3/8") maximum size, with none passing a 2.36mm (#200) sieve.
  - .1 Colour admixture: Normal grey cement as indicated.
- .4 Reinforcing steel: To CSA-G30.18, Grade 400.
- .5 Steel Pins: To CAN/CSA-G40.20/G40.21, Grade 300W.

### 2.2 CONCRETE MIXES

- .1 Prepare design mixes for each type of concrete required. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast concrete wheel stop fabricator's option.
- .2 Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by CSA standard.
- .3 Normal-Weight Concrete Mixes: Proportion mixes by either laboratory trial batch or field test data methods with materials to be used on Project, to provide normal-weight concrete with the following properties:
  - .1 Compressive Strength (28 Days): 34.5 MPa (5000 psi).
  - .2 Maximum Water-Cementitious Materials Ratio: 0.45

### 2.3 FABRICATION

- .1 Moulds: Accurately construct moulds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for pre-stressing operations.
- .2 Cast slots, holes, and other accessories in precast concrete wheel stop units to receive dowels and other similar work as indicated.
- .3 Reinforcement: Comply with recommendations in CPCI Manual of Standard Practice for fabricating, placing, and supporting reinforcement.
- .4 Mix concrete according to fabricators mix design requirements in this Section.

### 2.4 FINISHES

- .1 Exposed Exterior Smooth-Surface Finish: Provide surfaces free of pockets, sand streaks, and honeycombs, with uniform colour and texture.

## 3 Execution

### 3.1 EXAMINATION

- .1 Examine exposed surfaces for compliance with requirements for dimensional and elevation tolerances.

### **3.2 INSTALLATION**

- .1 Cast concrete wheel stops, nominally 2440mm (8') long to manufacturer's standard with smooth face profile and anchor holes at either end.
- .2 Orient precast concrete wheel stop units centred on parking stalls as illustrated. Anchor by driving 10mm (3/8") steel pins 305mm (12") into asphalt paving and sub-structure.
- .3 Remove and replace damaged precast concrete wheel stop units.

### **3.3 CLEANING**

- .1 Clean exposed surfaces of precast concrete wheel stop units after erection to remove markings, dirt and stains.
- .2 Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

**END OF SECTION**

1 General

1.1 SUMMARY

- .1 Provide labour, materials, products, equipment and services to complete painted traffic lines and marking Work in accordance with the Contract Documents.

1.2 REFERENCE STANDARDS

- .1 CAN/CGSB 1.74, Alkyd Traffic Paint.
- .2 FED-STD 595B, Standard Paint Colours.
- .3 OPSS 1712, Material Specification for Organic Solvent Based Traffic Paint.
- .4 OPSS 1713, Material Specification for Thermoplastic Pavement Marking Material.
- .5 OPSS 1714, Material Specification for Field Reacted Polymeric Pavement Marking Material.
- .6 OPSS 1750, Material Specification for Traffic Paint Reflectorizing Glass Beads.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's Product data indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and troubleshooting protocol.
    - .2 Product transportation, storage, handling and installation requirements.

1.4 QUALITY ASSURANCE

- .1 Applicator's qualifications: Perform Work of this Section by a company approved by manufacturer and having specialized equipment suitable for type of work specified.

1.5 SITE CONDITIONS

- .1 Do not install Work of this Section outside of following environmental requirements without manufacturer's written acceptance:
  - .1 Durable pavement marking material: Minimum 0°C and no forecast of rain within 4 h of start of application.
  - .2 Traffic paint: Ambient air and surface temperature minimum 5°C and maximum 43°C. Maximum relative humidity 85%, wind speed is less than 60 km/h and no forecast of rain within 4 h of start of application.

2 Products

2.1 MATERIALS

- .1 Durable Paint:
  - .1 Hot applied thermoplastic pavement marking material: to OPSS 1713, lead-free, colour to FED-STD 595B, Hot Extruded Thermoplastic Road Markings Material by Lafrenz Road Services Ltd.
  - .2 Cold applied plastic pavement marking material: Flexible 2 component, solvent free and lead free, cold curing acrylic or methacrylate road marking material to OPSS 1714, colour to FED-STD 595B, System 400 Road Markings Materials by Lafrenz Road Services Ltd.
- .2 Traffic Paint:



- .1 Organic solvent based, lead-free to OPSS 1712 or CAN/CGSB 1.74.

3 Execution

**3.1 EXAMINATION**

- .1 Verify pavement surface is properly cured. Report defects to Consultant.
- .2 Commencement of Work means acceptance of existing conditions.

**3.2 INSTALLATION**

- .1 Cold applied plastic pavement marking material to be used for parking lots and driveways.
- .2 Hot applied thermoplastic pavement marking material to be used for roadways.
- .3 Traffic paint to be used for all other parking areas.

**3.3 PREPARATION**

- .1 Clean pavement surface and remove loose material.
- .2 Verify pavement surface is free from ponding water, frozen matter, dust, oil, grease, scaling or laitance and other foreign matter detrimental to performance.
- .3 Prohibit traffic in work area, until Work of this Section is complete.

**3.4 APPLICATION**

- .1 Lay out traffic lines and markings as indicated on the Drawings and in accordance with manufacturer's instructions.
- .2 Apply durable pavement marking material [with reflectorizing glass beads] using marking machine. Minimum 1.90 mm  $\pm$  0.40 mm measured dry film thickness.
- .3 Apply traffic paint to achieve uniform colour and density. Coverage shall be 3 sq.m/L (150 sq.ft./gal).
- .4 Provide adequate shielding or masking during spray application of traffic paint.
- .5 Make lines 100 mm wide unless otherwise indicated.
- .6 Lines shall be parallel and have neat, straight, clean sharp edges. Lines shall be of uniform colour and density.
- .7 Paint markings to be within plus or minus 12 mm of dimensions indicated.
- .8 Refinish ragged edges or lines incorrectly laid out. Remove incorrect lines. Make inconspicuous.

**3.5 PROTECTION**

- .1 Supply and install temporary barricades and traffic cones to protect freshly painted line Work from being marked or otherwise disturbed until after paint is dry.
- .2 Remove temporary barricades and traffic cones when Work is complete and ready for traffic.

**END OF SECTION**

1 General

**1.1 RELATED DOCUMENTS**

- .1 Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specifications Section, apply to this Section.

**1.2 DESCRIPTION**

- .1 This Section specifies furnishing and installing cast-in-place tactile warning surface tiles where indicated.

**1.3 SUBMITTALS**

- .1 Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- .2 Samples for Verification Purposes: Submit one (1) 12" x 12" size tile sample.
- .3 Shop drawings are required for products specified showing fabrication details, composite structural system, tile surface profile, fastener and anchor locations, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.
- .4 Material Test Reports: Submit complete test reports from qualified accredited independent testing laboratories to qualify that materials proposed for use are in compliance with requirements and meet or exceed the properties indicated on the specifications. All tests shall be conducted on a Cast in Place Warning tile (or approved equal) as certified by a qualified independent testing laboratory.
- .5 Maintenance Instructions: Submit copies of manufacturer's specified installation and maintenance practices for each type of Warning tile and accessory as required.

**1.4 QUALITY ASSURANCE**

- .1 Provide Cast in Place Warning tiles and accessories as produced by a single manufacturer with a minimum of three (3) years' experience in the manufacturing of Cast in Place Warning tiles.
- .2 Installer's Qualifications: Engage an experienced installer certified in writing by Cast in Place Warning tile manufacturer as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for the project.
- .3 Provide Cast in Place Warning tiles which are in compliance with the following standards (or most recent):
  - .1 AODA, Accessibility for Ontarians with Disabilities Act, 2005.
  - .2 CSA/ASC B651, Accessible design for the built environment.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Cast in Place Warning tiles shall be suitably packaged or crated to prevent damage in shipment and handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.
- .2 Cast in Place Warning tiles shall be delivered to location at building site for storage prior to installation.

**1.6 SITE CONDITIONS**

- .1 Environmental Conditions and Protection: Maintain minimum temperature of 41°F in spaces to receive Cast in Place Warning tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

- .2 The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public.

## 1.7 WARRANTY

- .1 Material: Warrant material in writing for a period of five (5) years from date of substantial completion. Warranty includes factory defects, breakage, and deformation.
- .2 Installation: Warrant installation in writing for a period of two (2) years.

## 2 Products

### 2.1 PERFORMANCE REQUIREMENTS

- .1 Product Data: Vitrified Polymer Composite (VPC) Cast in Place Warning tiles shall meet or exceed the following test criteria:
  - .1 Compressive Strength: To ASTM D 695;  $\geq 28,000$  psi
  - .2 Flexural Strength: To ASTM D 790;  $\geq 25,000$  psi
  - .3 Tensile Strength: To ASTM D 638;  $\geq 19,000$  psi
  - .4 Impact Resistance: To ASTM D 5420;  $\geq 550$  in-lbf/in
  - .5 Coefficient of Thermal Expansion: To ASTM D 696;  $2.78 \times 10^{-6}/^{\circ}\text{F}$
  - .6 Flame Spread Index: To ASTM E 84;  $\leq 25$
  - .7 Water Absorption: To ASTM D 570;  $\leq 0.05\%$
  - .8 Chemical Resistance: To ASTM D 543; No Failure

### 2.2 MATERIALS

- .1 Tactile Warning Surface:
  - .1 Vitrified Polymer Composite (VPC) Cast in Place Warning tiles shall be an epoxy polymer composition with a ultra-violet coating employing aluminum oxide particles in the truncated domes.
  - .2 Basis of Design Material: Armor Tile as distributed under license by Engineered Plastics, or approved equivalent as accepted by the Consultant.
  - .3 Dimensions: The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.9" base diameter, 0.45" top diameter spaced center-to-center 2.35" as measured on a diagonal and 1.67" as measured side by side in-line.
  - .4 Colour: Homogeneous throughout the tile; Colour: Federal Yellow.

## 3 Execution

### 3.1 INSTALLATION

- .1 During cast in place tactile warning surface tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.
- .2 Prior to placement review manufacturer and contract drawings prior to the construction and refer any and all discrepancies to the Consultant.
- .3 The specifications of the structural embedment flange system and related materials shall be in strict accordance with the contract documents and the guidelines set by their respective manufacturers. Not recommended for asphalt applications.

- .4 The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 – 7 inches to permit solid placement of the tactile warning surface.
- .5 The factory-installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.
- .6 When preparing to set the tile, it is important that no concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes in the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each embedment flange on the underside of the tile. This will lock the tile solidly into the cured concrete.
- .7 The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, the electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. The Cast in Place Warning tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.
- .8 In cold weather climates, cast in tiles deeper such that the top of domes are level to the adjacent concrete on the top and sides of ramp and that the base of domes to allow water drainage. This installation will reduce the possibility of damage due to snow clearing operations.
- .9 Immediately after placement, the tile elevation is to be checked to adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. Ensure that the field surface of the tile is flush with the surrounding concrete and back of curb so that no ponding is possible on the tile at the back side of curb.
- .10 While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.
- .11 During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning or external forces placed on the tile that may rock the tile causing a void between the underside of tile and concrete.
- .12 Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two suitable weights of 25 lb each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.
- .13 Remove protective wrap from tile surface once concrete has cured.

### **3.2 CLEANING, PROTECTING AND MAINTENANCE**

- .1 Protect tiles against damage during construction period to comply with Warning tile manufacturer's specification.
- .2 Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- .3 Comply with manufacturer's maintenance manual for cleaning and maintaining tile surface and it is recommended to perform annual inspections for safety and integrity.

**END OF SECTION**

1 General

1.1 SUMMARY

- .1 Supply and install chain link fencing, complete with [swing][sliding] gates, as indicated in this Section.

1.2 RELATED REQUIREMENTS

- .1 Section 03 30 00: Cast-in-Place Concrete
- .2 Section 32 16 26: Concrete Curbs and Sidewalks
- .3 Section 32 31 19: Ornamental Metal Fencing and Gates

1.3 QUALITY ASSURANCE

- .1 Qualifications:
  - .1 Manufacturer and tradesmen executing the work of this Section shall have had a minimum 5 years continuous Canadian experience in successful manufacture and installation of work of type and quality shown and specified. Submit proof of experience upon Consultant's request.
  - .2 Erection of chain link fencing and gates shall be by workers especially trained and experienced in this type of work. Have a senior, qualified representative at the job site to direct the work of this Section at all times.

1.4 SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00.
- .2 Shop Drawings:
  - .1 Submit fully dimensional shop drawings to Consultant showing construction, assembly, elevations, sections and interfacing with work of other Sections.
  - .2 No work of this Section shall be fabricated until shop drawings and all other related submittals, documentation, certifications and samples as required by this Section, have been reviewed by Consultant.
  - .3 Details shall indicate metal thicknesses, fasteners and welds, all anchorage assemblies and components and erection details.
- .3 Samples:
  - .1 Submit to Consultant for approval, samples of materials and components to be used in the systems, prior to fabrication of work together with name of manufacturer and technical literature. Submit 12" x 12" samples of chain link fence fabric in colour as selected by the Consultant.

2 Products

2.1 APPROVED MANUFACTURERS

- .1 Subject to compliance with specifications, use products of one of the following:
  - .1 McGowan Fence and Supply Ltd., or;
  - .2 Lundy Fence, Division of IVACO Inc., or;
  - .3 Peel Fence Systems Inc., or;
  - .4 Approved equal.

## 2.2 MATERIALS

- .1 Steel Pipe: Conforming to CAN/CGSB-138.2-M80.
- .2 Fabric: No.9 gauge (0.148" nominal) ultra violet light resistant, P.V.C. coated, galvanized steel wire in 2" mesh, with both top and bottom selvages twisted and barbed, conforming to CAN/CGSB-138.1-M80.
- .3 End, Corner, and Pull Posts: Galvanized steel, minimum sizes and weights as follows;
  - .1 Up to 6'-0" Fabric Height: 2.375" outside diameter pipe, 3.65 lbs/lin. ft.
  - .2 Over 6'-0" Fabric Height: 2.875" outside diameter pipe, 5.79 lbs/lin. ft.
- .4 Line Posts: Galvanized steel, minimum sizes and weights as follows;
  - .1 Up to 6'-0" Fabric Height: 1.90" outside diameter pipe, 2.70 lbs/lin. ft.
  - .2 Over 6'-0" to 8'-0" Fabric Height: 2.375" outside diameter pipe, 3.65 lbs/lin. ft.
  - .3 Over 8'-0" Fabric Height: 2.875" outside diameter pipe, 5.79 lbs/lin. ft.
- .5 Gate Posts: Galvanized steel, for single gate or double leaf gate as follows;
  - .1 Up to 6'-0" Fabric Height: 2.875" outside pipe diameter, 5.79 lbs/lin. ft.
  - .2 Over 6'-0" Fabric Height: 4" outside diameter pipe, 9.11 lbs/lin. ft.
- .6 Top Rail and Intermediate Rails: Galvanized steel, manufacturer's longest lengths as follows:
  - .1 Typical: 1.66" outside diameter pipe, 2.27 lbs/lin. ft.
  - .2 Couplings: Expansion type, approximately 6" long.
  - .3 Attaching Devices: Means of attaching top rail securely to each gate, corner, pull, and end post.
- .7 Sleeves: Galvanized steel pipe with inside diameter not less than 1/2" greater than outside diameter of pipe. Provide steel plate closure welded to bottom of sleeves of width and length not less than 1" greater than outside diameter of sleeve as follows;
  - .1 Up to 6'-0" Fabric Height: Provide sleeve not less than 12" long.
  - .2 Over 6'-0" Fabric Height: Provide sleeve not less than 24" long.
- .8 Tension Wire: Minimum No.7 gauge galvanized steel, coated coil spring wire, located at bottom of fence fabric.
- .9 Wire Ties: Minimum No.11 gauge galvanized steel.
- .10 Post Brace Assembly: Manufacturer's standard adjustable brace at end posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same materials as top rail for brace, and truss to line posts with 0.375" diameter rod and adjustable tightener.
- .11 Post Tops: Galvanized steel, weather tight closure cap for tubular posts, one cap for each post. Furnish cap with openings to permit passage of top rail.
- .12 Stretcher Bars: Galvanized steel, one piece lengths equal to full height of fabrics with minimum cross section of 3/16" x 3/4" inch. Provide one stretcher bar for each gate and end post, and two for each corner and pull post.
- .13 Stretcher Bar Bands: Manufacturer's standard.
- .14 Gate Hardware:
  - .1 Swinging Gate Hardware:
    - .1 Hinges: Offset type hinges to permit 180° gate opening. Provide 1-1/2 pair of hinges for each gate leaf over 6'-0" height.

- .2 Latches: Forked or plunger bar type to permit operation from both sides of gate, with padlock eye.
- .2 Double Leaf Gate Hardware:
  - .1 As specified herein for swinging gate hardware and in addition provide "mushroom" type flush plate gate stops with anchors set in concrete to engage centre drops rod/plunger bar. Arrange stops for use with one padlock to lock both gate leaves.
- .3 Sliding Gate Hardware:
  - .1 Manufacturer's standard heavy-duty track, ball bearing hanger sheaves, overhead framing and supports, guides, stays bracing and accessories as required.
- .15 Gate Cross-Bracing: 3/8" diameter galvanized steel adjustable length truss rods.

## 2.3 SETTING GROUT

- .1 Concrete: Minimum 20 MPa. Refer to Section 03 30 00.
- .2 Grout: Premixed, factory-packaged, non-staining, non-corrosive grout. Refer to Section 03 30 00. Provide type especially formulated for exterior application.

## 2.4 FINISHES

- .1 Galvanize as follows:
  - .1 Fabric: Not less than 1.2 oz zinc/sq ft.
  - .2 Framing: Not less than 1.8 oz zinc/sq ft.
- .2 P.V.C. Coating:
  - .1 Ultra violet light resistant, polyvinyl chloride (PVC) coating shall be applied by field bed method to preheated substrate, to 10 to 14 mils dry film thickness (DFT) on pipe and 7 to 10 mils dry film thickness (DFT) on fence fabric.
  - .2 Clean and pretreat surfaces as required to thermally bond the P.V.C. coating to surfaces.
  - .3 Colour shall be as selected later by Consultant from manufacturer's full available colour range.

## 2.5 FABRICATION

- .1 Fabricate swing gate perimeter frames of 1.90" outside diameter galvanized steel pipe. Provide horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware, and accessories. Gates shall conform to CAN/CGSB-138.4-M82. Space frame members maximum 8'-0" apart.
- .2 Assemble gate frames rigidly by welding or with special fittings and rivets. Use same fabric as specified for fence. Install fabric with stretcher bars at vertical edges. Bars may also be used at top and bottom edges. Attach stretchers to frame at 12" O.C. Install diagonal cross-bracing on gates as required to ensure frame rigidity without sag or twist.
- .3 Attach hardware to provide security against removal or breakage.
- .4 Fabricate swing gates, double gates and sliding gates as indicated on drawings.

## 3 Execution

### 3.1 INSTALLATION

- .1 Install chain link fencing in strict accordance with CAN/CGSB-138.3-M80 and as specified herein.
- .2 Space line posts at 10'-0" O.C. maximum.

- .3 Methods for Setting Posts:
  - .1 Grade-Set Posts: Drill holes for post with auger or hand excavate. Excavate each post hole to minimum 12" diameter, or not less than 4 times the post diameter. Excavate to 4" below bottom of post. Set bottoms of posts 6" below "frost line". Hold, brace posts plumb, level while placing, consolidating and finishing concrete.
  - .2 Sleeve-Set Posts In Concrete: Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. Insert posts into sleeves and fill annular space between post and sleeve solid with grout. Mix and place grout in accordance with manufacturer's written instructions.
- .4 Intermediate Rails: Provide centre rails where indicated. Install in one piece between posts and flush with post on fabric side, using offset fittings where necessary.
- .5 Brace Assemblies: Install braces so posts are plumb with rod in tension.
- .6 Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with minimum No.6 gauge galvanized wire. Fasten fabric to tension wire using No.11 gauge galvanized steel hog rings at 24" O.C.
- .7 Fabric: Leave approximately 2" between finish grade and bottom selvage. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so fabric remains in tension after pulling force is released.
- .8 Stretcher Bars: To secure end, and pull posts, thread through or clamp to fabric 4" O.C. and secure to posts with metal bands spaced on 12" O.C.
- .9 Tie Wires:
  - .1 Use U-shaped wire conforming with diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted two full turns. Bend wire ends to minimize hazards to persons or clothing.
  - .2 Tie fabric to line posts with wire ties spaced 12" O.C. Tie fabric to rails and braces with wire ties spaced 24" O.C. Manufacturer's standard procedure will be accepted if of equal strength and durability.
- .10 Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- .11 Install swing gates, double gates and sliding gates plumb, level and secure for full openings, without interference. Set all ground set hardware in concrete for secure anchorage. Adjust and lubricate all gate hardware for smooth and efficient operation.

**END OF SECTION**



## 1.1 SUMMARY

1. This Section specifies requirements for design, supply, and installation of decorative aluminum fences, manual swing gates, and gate hardware.

## 1.2 RELATED REQUIREMENTS

1. Other sections of the specification referring to this section, coordinate requirements of related sections and requirements.

## 1.3 REFERENCE STANDARDS

1. All reference standards specified herein imply the latest edition of the standard.
2. American Society for Testing and Materials (ASTM International):
  1. ASTM B26/B26M-18e1, Standard Specification for Aluminum-Alloy Sand Castings
  2. ASTM B209/B209M-21a, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  3. ASTM B221-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  4. ASTM B221M-21, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
  5. ASTM B247-20, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
  6. ASTM B247M-20, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings (Metric)
  7. ASTM B429/B429M-20, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
3. Fenestration & Glazing Industry Alliance (FGIA):
  1. AAMA 2603-22, \*Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)

## 1.4 ADMINISTRATIVE REQUIREMENTS

1. Pre-Construction Meetings: Conduct a pre-construction meeting at Project site in accordance with Section 01 31 19 – Project Meetings attended by Contractor, Subcontractor, Consultant, materials supplier(s), and other relevant personal before commencement of Work for this Section to review methods and procedures related to decorative metal fences and gates including, but not limited to, the following:
  1. Confirmation of specifications and details for the project.
  2. Required welding and jointing methods.
  3. Installation requirements and coordination with other components of the Work.
  4. Review of samples and mock-ups.
2. Coordination: Coordinate components of the work of this Section with work performed by other Sections in sufficient time to allow for other components of the work to incorporate requirements of this Section without causing delay to the work, including the following:
  1. Concrete: Coordinate requirements for casting in of anchors and other components with Division 03 – Concrete.

## 1.5 SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
2. Action Submittals: Provide the following submittals before starting any work of this Section:

1. Product Data: Submit manufacturer's product data for each fabricated component specified in this Section, mark submittals indicating standard choices or modifications required to meet project requirements.
2. Shop Drawings: Submit shop drawings including plans, elevations, sections, gate locations, posts spacing, and mounting attachment details.
3. Samples for Verification: Submit samples for verification by Consultant for each type of fence material and finish specified, provide sample in 300 mm lengths unless noted otherwise.
3. Sustainable Design Submittals: Coordinate project sustainable design requirements with Section 01 81 13 – Sustainable Design Criteria.

#### **1.6 PROJECT CLOSEOUT SUBMISSIONS**

1. Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in operations manual in accordance with Section 01 78 23 – Operation and Maintenance Data; provide specific warning of any maintenance practice or material that may damage or disfigure finished Work.

#### **1.7 QUALITY ASSURANCE**

1. Qualifications: Provide proof of qualifications when requested by Consultant, and as follows:
  1. Fabricator Qualifications: Engage a fabricator experienced in fabricating decorative metal fences and gates similar to that indicated for this Project with a record of successful in-service performance, as well as sufficient production capacity to fabricate decorative metal and fences without delaying the Work.
  2. Installer Qualifications: Engage an experienced installer who has completed work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

#### **1.8 MOCK-UPS**

1. Provide mock-ups in accordance with Section 01 45 00 – Quality Control to demonstrate aesthetic effects and set quality standards for fabrication and installation, and as follows:
  1. Build mock-ups to verify selections made under sample submittals to demonstrate aesthetic effects, and to set quality standard for fabrication and installation, and as follows:
    1. Include a 3-metre length of fence complying with requirements specified in this Section.
    2. Subject to compliance with requirements, approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Performance.

#### **1.9 SITE CONDITIONS**

1. Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where specified products are indicated to fit together with other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
2. Established Dimensions: Establish dimensions and proceed with fabricating specified products without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for shimming and fitting.

### **2 Products**

#### **2.1 PERFORMANCE REQUIREMENTS**

1. Wind Pressure: 0.43 kPa 1/50-year occurrence in accordance with requirements of the Ontario Building Code.

## 2.2 MATERIALS

1. Aluminum: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.
  1. Extrusions: To ASTM B221 or ASTM B221M, Alloy 6063-T5.
  2. Tubing: To ASTM B429/B429M, Alloy 6063-T6.
  3. Plate and Sheet: To ASTM B209/B209M, Alloy 6061-T6.
  4. Die and Hand Forgings: To ASTM B247 or ASTM B247M, Alloy 6061-T6.
  5. Castings: To ASTM B26/B26M, Alloy A356.0-T6.

## 2.3 DECORATIVE ALUMINUM FENCES AND GATES

1. Fences and gates made from aluminum extrusions, and as follows:
  1. Posts: Square extruded tubes as follow:
    1. Line Posts: Nominal 50 mm x 50 mm with 3.2 mm thick installed on base plates.
    2. End and Corner Posts: Nominal 50 mm x 50 mm with 3.2 mm thick.
    3. Swing Gate Posts: Nominal 65 mm x 65 mm with 3.2 mm thick.
  2. Posts Caps: Aluminum castings that cover entire top of posts as specified above.
  3. Rails: Extruded aluminum channels, 38 mm x 38 mm with 2.54 mm thick sidewalls and 1.78 mm thick top.
  4. Perforated Aluminum Metal Sheet:
    1. Hole Type: Round.
    2. Material: Aluminum sheet, alloy 3003-H14.
    3. Hole Pattern: Nominal 12 mm round on 17 mm staggered centres.
    4. Hole Arrangement: 60 degrees staggered centres.
    5. Percent Open Area: 48 percent.
    6. Thickness: Minimum 3.2 mm.
  5. Swing Gates: Single leaf gate configuration in width and height as indicated on Drawings, fabricated from square extruded-aluminum tubes nominal 50 mm x 50 mm with 3.2 mm wall thickness, welded and using perforated aluminum metal sheet panels specified above.

## 2.4 ACCESSORIES

1. Fasteners: Manufacturer's standard concealed fastening system.
2. Gate Hardware:
  1. Hinges: To BHMA A156.17, Grade 1, Structurally designed to support all gates without deformation during opening and closing. Allows a 180° rotation during both opening and closing.
  2. Latch: To permit operation from both sides of gates. Fabricate latches with integral eye opening for padlocking; padlock to be made accessible from both sides of gate.

## 2.5 FINISHES

1. Aluminum Finishes: Powder-Coat Finish: To AAMA 2603 except with a minimum dry film thickness of 0.05 mm (2 mils). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish, and as follows:
  1. Colour and Gloss: As selected by Consultant from manufacturer's standard colour and designation range.

## 2.6 FABRICATION

1. Assemble decorative metal fences or gates by welding perforated metal sheets to rails and posts, and as follows:
  1. Fabricate sections with clips welded to rails field fastenings to posts.
  2. Drill clips for fasteners before finishing.

2. Finish exposed welds to be completely sanded joint, uniform undressed welds with minimal splatter.

### **3 Execution**

#### **3.1 EXAMINATION**

1. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

1. Install decorative metal fences and gates in accordance with manufacturer's written instructions and reviewed shop drawings.
2. Fit panels together to form tight, hairline joints, free from distortion and other defects.
3. Perform cutting, drilling, and fitting required for installing fence panels. Set panels accurately in location, alignment, and elevation; measured from established lines and levels and free of rack, and as follows:
  1. Do not weld, cut, or abrade surfaces of fence components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
4. Align panel tops so variations from level for horizontal members do not exceed 6 mm in 3600 mm unless otherwise shown on the Drawings.
5. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with concrete or dissimilar metals, with a heavy coat of bituminous paint.
6. Conceal anchor bolts and screws whenever possible; where not concealed, use flush countersunk fastenings.

#### **3.3 CLOSEOUT REQUIREMENTS**

1. Adjusting: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
2. Repairing: Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items which cannot be refinished in the field to the shop. Make required alterations and refinish affected area so that it is indistinguishable from adjacent undamaged areas. Provide new components where finishes cannot be restored to undamaged condition.
3. Protection: Protect finishes of fence components from damage during construction period with temporary protective coverings approved by fence manufacturer. Remove protective coverings at time of Substantial Performance.

**END OF SECTION**

1 General

**1.1 INTENT OF SECTION**

- 1.1.1 Without in anyway limiting the scope of work, this section covers disinfecting and hydrostatic and pressure testing of potable water piping. Conduct disinfection and leakage testing as required and specified herein or in various other sections in the specification or as directed by the Engineer / Consultant.
- 1.1.2 The Contractor shall furnish all potable water, disinfecting chemicals, mixing equipment, suitable temporary service connections, testing plugs or caps, pressure pumps, pipe connections, gauges, thrust supports, expelling air, pumping to the required test pressure, dewatering the line or structure and flushing, all other required equipment and all labour required, without additional compensation, preparatory to commissioning the project.
- 1.1.3 The Contractor shall employ qualified specialists to flush, test and disinfect the potable water piping.
- 1.1.4 The Contractor shall prepare and submit a watermain commissioning plan as per the City of Welland requirements. No watermain commissioning can commence until the plan has been approved by the City and the Engineer / Consultant.

2 Products

**2.1 WATER**

- 2.1.1 The Contractor shall provide and supply all necessary equipment for obtaining water necessary to carry out all work involved in this section.
- 2.1.2 All water used for disinfection and pressure testing shall be of potable quality as defined by the latest edition of the Ontario Drinking Water Standards.
- 2.1.3 The Contractor will be responsible for coordinating the rate and conditions for supply of this water. No extra payment will be made to the Contractor for delays resulting from a curtailment of supply.

**2.2 CHEMICAL FORM**

- 2.2.1 Chlorine used in disinfection shall be crystalline calcium hypochlorite or sodium hypochlorite as defined by AWWA Standard B300.

**2.3 BACTERIOLOGICAL SAMPLING AND TESTING**

- 2.3.1 Before the potable water services are placed in service, bacteriological sampling and testing shall be performed in accordance with the City of Welland Municipal Specifications, and MECP Watermain Disinfection Procedure, Latest Version.
- 2.3.2 The Contractor shall be responsible for sending the samples to a registered laboratory for testing.
- 2.3.3 Analytical fees for the sampling will be paid for by the Owner.

**2.4 DISPOSAL OF DISINFECTING AND TESTING WATER**

- 2.4.1 Dispose of water used for disinfection and the initial testing into the surface drainage system after dechlorination at a rate which will not cause hydraulic overloading and which will meet the requirements of the Ontario Ministry of the Environment with respect to discharge of chlorinated water. (No chlorinated water shall be discharged into surface drainage.) The Contractor shall be responsible for the necessary equipment required to pump the test water to the drain.

## **2.5 CODES AND STANDARDS**

- 2.5.1 Disinfection shall be carried out in strict accordance with MECP Watermain Disinfection Procedure, August 1, 2020, and the C651 - AWWA Standard for Disinfection Water Mains.
- 2.5.2 Should there be conflicts between the above-noted standards or with the specifications, the more stringent provisions shall apply.

## **2.6 ACCEPTABLE SPECIALIST SUB-CONTRACTOR**

- 2.6.1 The specialists shall be fully experienced in providing disinfection services of potable water piping and shall provide references of disinfection work completed in Ontario. Should the Contractor intend on completing the disinfection work themselves, they shall provide references of their experience.
- 2.6.2 Sub-contractor must be licensed.

## **3 Execution**

### **3.1 MIXING OF CHLORINE SOLUTIONS**

- 3.1.1 Mixing of chlorine solutions shall conform to the Manufacturer's instructions. Methods and procedures shall be subject to the approval of the Engineer / Consultant.

### **3.2 DISINFECTION**

- 3.2.1 Prior to disinfection, clean the inside of the pipe thoroughly. Remove all dirt and loose material. Rinse with clean, potable water.
- 3.2.2 Chlorine is a lethal chemical. The Contractor shall provide all necessary safety and respiratory apparatus required to carry out his work. Personnel involved in this work shall be made familiar with all precautions and procedures applicable prior to commencing this work. All applicable safety regulations shall be rigidly adhered to.

### **3.3 DEFECTS AND REPAIRS**

- 3.3.1 Defects disclosed in the work shall be repaired and retested or the work replaced without additional costs to the Owner.
- 3.3.2 Tests shall be repeated after any work has been replaced, if in the judgment of the Engineer / Consultant it is necessary.
- 3.3.3 Test readings shall be done in the presence of the Engineer / Consultant and City representative.

**END OF SECTION**