



Waypoint Centre for Mental Healthcare Toanche Building 3rd Floor Renovation Project

Client Project Number 205004
CannonDesign Project Number 020708.51

Project Manual ISSUED FOR TENDER

Divisions 00 through 28

December 18, 2023

CannonDesign
Architect

CANNONDESIGN

Part 1 General

1.1 **PROFESSIONAL SEALS AND SIGNATURES**

- .1 Professional seals and signatures are provided as required by the Ontario Building Code (latest edition), Ontario Regulation 403/97 (350/06), Subsection 2.3.1 (Division C, Part 1, Subsection 1.2.1) and amendments thereto, for the Project stated herein and apply only to those documents and Specifications prepared by the respective Architect of Record, Structural Engineer of Record, Mechanical Engineer of Record and Electrical Engineer of Record as designated by the design discipline symbols A, S, M, and E in Document 00 01 10 - List of Contents. The professional seals and signatures stated below are as follows:

1.2 **DESIGN PROFESSIONALS OF RECORD**

.1 Architect/Consultant:

.1 **CANNONDESIGN**

.2 50 Fountain Plaza, Suite 200, Buffalo NY, 14202. Telephone: (716) 773-6800. Facsimile: (716) 773-5909.

.3 Responsible for Sections as indicated in 00 01 10 – Table of Contents, except where indicated as prepared by other design professionals of record.

.2 Structural Engineer:

.1 **STEPHENSON ENGINEERING**

.2 2550 Victoria Park Avenue, Suite 602, Toronto ON, M2J 5A9. Telephone: (416) 635-9970.

.3 Responsible for Sections as indicated in 00 01 10 – Table of Contents, except where indicated as prepared by other design professionals of record.

.3 Mechanical Engineer:

.1 **HH ANGUS**

.2 1127 Leslie Street, Toronto, ON, M3C 2J6. Telephone: (416) 443-8200. Facsimile: (416) 443-8290. Toll Free: (866) 955-8201

.3 Responsible for Sections as indicated in 00 01 10 – Table of Contents, except where indicated as prepared by other design professionals of record.

.4 Electrical Engineer:

.1 **MULVI & BANANI INC.**

.2 Contact: Ian Ma

.3 90 Sheppard Avenue East, Suite 500, Toronto, Ontario, M2N 3A1. Telephone: (416) (416) 751-2122.

.4 Responsible for Sections as indicated in 00 01 10 – Table of Contents, except where indicated as prepared by other design professionals of record.

Part 2 Products - Not Used.

Part 3 Execution - Not Used.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

00 01 07	Seals Page
00 01 10	Table of Contents
00 01 15	List of Drawing Sheets

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

00 21 13	Instructions to Bidders
00 31 26	Existing Hazardous
00 73 03	Supplementary Conditions

DIVISION 01 – GENERAL REQUIREMENTS

01 10 00	Owner General Requirements
01 11 00	Summary of Work
01 11 20	Contract Assignment
01 14 00	Work Restrictions
01 21 00	Allowances
01 22 00	Unit Prices
01 25 00	Substitution Procedures
01 26 00	Contract Modification Procedures
01 29 00	Payment Procedures
01 31 19	Project Meetings
01 32 00	Construction Progress Documentation
01 33 00	Submittal Procedures
01 35 13.53	Special Project Procedures for Mental Health Facilities
01 35 23	Health and Safety
01 40 00	Quality Requirements
01 51 00	Temporary Utilities
01 52 00	Construction Facilities
01 56 00	Temporary Barriers and Enclosures
01 57 00	Temporary Controls
01 61 00	Common Product Requirements
01 71 00	Examination and Preparation
01 73 00	Execution
01 73 29	Cutting and Patching
01 74 00	Cleaning and Waste Management
01 77 00	Closeout Procedures
01 78 00	Closeout Submittals
01 79 00	Demonstration and Training
01 88 53	Behavioral Health Facilities Performance Requirements
01 91 00	General Commissioning Requirements

DIVISION 02 – EXISTING CONDITIONS

02 41 19.16	Selective Interior Demolition
-------------	-------------------------------

DIVISION 03 – CONCRETE

03 54 16	Hydraulic Cement Underlayment
----------	-------------------------------

DIVISION 05 – METALS

05 50 00	Metal Fabrications
----------	--------------------

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

06 06 20	Decorative Plastic Laminate
06 10 53	Miscellaneous Rough Carpentry

06 40 00 Architectural Woodwork

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 84 00 Firestopping
 07 92 00 Joint Sealants

DIVISION 08 – OPENINGS

08 11 00 Metal Doors and Frames
 08 31 13 Access Doors and Frames
 08 31 13.53 Security Access Doors and Frames
 08 51 13 Aluminum Windows
 08 71 00 Door Hardware
 08 80 00 Glazing

DIVISION 09 – FINISHES

09 05 61 Moisture Vapour Emission Control
 09 21 16 Gypsum Board Assemblies
 09 22 16 Non-Structural Metal Framing
 09 30 00 Tiling
 09 51 13 Acoustical Panel Ceilings
 09 65 13 Resilient Base and Accessories
 09 65 16 Resilient Sheet Flooring
 09 65 19 Resilient Tile Flooring
 09 66 23 Resinous Matrix Terrazzo Flooring
 09 72 16 Vinyl Coated Fabric Wall Coverings
 09 77 50 Sanitary Wall Panel Systems
 09 81 00 Acoustic Insulation and Sealants
 09 91 23 Interior Painting

DIVISION 10 - SPECIALTIES

10 11 00 Visual Display Units
 10 26 00 Wall and Door Protection
 10 28 00 Toilet, Bath, and Laundry Accessories
 10 44 00 Fire Protection Specialties
 10 51 13 Metal Lockers

DIVISION 11 – EQUIPMENT

11 73 13 Psychiatric Seclusion Room Wall Padding

DIVISION 12 – FURNISHINGS

12 36 61.16 Solid Surface Countertops

DIVISION 20 – COMMON WORK RESULTS

HHA

20 01 01 Mechanical General Requirements
 20 01 02.ON Qualifications and Authorities – Ontario
 20 01 13 Definitions and Abbreviations
 20 05 01 Basic Materials and Methods
 20 05 02 Painting for Mechanical Services
 20 05 12 Common Electrical Requirements for Mechanical Services
 20 05 13 Common Motor Requirements for Mechanical Equipment
 20 05 14.13 Constant Speed Motor Controllers
 20 05 16 Flex Connections, Expansion Joints, Anchors & Guides
 20 05 19 Indicating Gauges
 20 05 23 General Requirements for Valves

20 05 24	Welding and Brazing
20 05 29	Common Hanger and Support Requirements for Piping
20 05 48	Vibration Isolation
20 05 49	Seismic Restraint for Mechanical Services
20 05 53	Identification for Mechanical Services
20 05 73.13	Mechanical Services for General Facility Equipment
20 07 11	Common Requirements for Mechanical Insulation
20 07 13	Ductwork Insulation
20 07 16	Equipment Insulation
20 07 19	Piping Insulation
20 77 19.20	Closeout Requirements for Mechanical Work CCDC 2020

DIVISION 22 – PLUMBING

HHA

22 05 01	Common Work Results for Plumbing
22 05 23.13	General Duty Valves for Plumbing Piping
22 05 93	Testing, Adjusting and Balancing for Plumbing
22 11 16.13	Domestic Water Piping – Copper
22 11 19	Domestic Water Piping Specialties
22 13 16.13	Sanitary Waste and Vent Piping – Cast Iron and Copper
22 13 19.13	Sanitary Drains
22 42 00	Plumbing Fixtures
22 45 00	Emergency Plumbing Fixtures

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING

HHA

23 05 01	HVAC Piping Systems General Requirements
23 05 23.13	General Duty Valves for HVAC Water Piping
23 05 93.13	Testing, Adjusting and Balancing for HVAC
23 05 93.23	TAB Supplement for Healthcare
23 21 13.23	Hydronic Piping – Carbon Steel
23 21 13.33	Hydronic Piping – Copper
23 21 16	Hydronic Piping Specialties
23 31 01	Air Distribution – General
23 31 13.13	Metal Ducts
23 33 05	Duct Accessories
23 33 13.11	Manual Balancing Dampers
23 33 13.13	Control Dampers
23 33 13.16	Fire and Smoke Dampers
23 33 13.23	Backdraft Dampers
23 33 16	Flexible Ducts
23 33 19	Duct Silencers
23 33 63	Louvres
23 34 16	HVAC Fans
23 37 13	Grilles, Registers, and Diffusers
23 41 11	Particulate Air Filters
23 82 23	Fan Coil Units
23 83 16	Radiant Ceiling Panels

DIVISION 25 – INTEGRATED AUTOMATION

HHA

25 05 01	Building Automation Common Work Results
25 05 06	Work on Existing Building Automation Systems
25 05 12	Building Automation Control Panels and Wiring
25 30 13	Building Automation Actuators and Operators
25 30 16.13	Building Automation Instrumentation
25 30 19.13	Building Automation Control Valves

Waypoint Centre for Mental Healthcare
Toanche Building 3rd Floor Renovation Project
Penetanguishene, ON, Canada
CannonDesign Project No. 020708.51

December 18, 2023
ISSUED FOR TENDER

25 30 23.13 Building Automation Control Dampers
25 90 01 Building Automation Control Sequences

DIVISION 27 – COMMUNICATIONS

MBII

27 52 23 Audio Visual Nurse Call System

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

MBII

28 13 01 Security Systems

END OF TABLE OF CONTENTS

Part 1 General

1.1 **LIST OF DRAWINGS**

.1 *Drawings:*

.1 *Drawings* consist of the *Drawings* and other drawings listed on the separately bound *Drawing* set, found on Drawing G0001 as modified by subsequent Addenda and *Contract* modifications.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 INVITATION

.1 Bid Call

- .1 Ensure offers are signed under seal, executed and dated and are received by the Owner at purchasing@waypointcentre.ca before 2:00 pm local time on, Thursday the 7th day of March 2024.
- .2 Offers submitted after above time may be returned to bidder unopened.
- .3 Submit Supplementary bid Information Form within twenty-four (24) hours after bid closing time.
- .4 Offers will be opened privately immediately after time for receipt of bids.
- .5 Amendments to submitted offer will be permitted if received in writing prior to bid closing and if endorsed by same party or parties who signed and sealed offer.

1.2 INTENT

- .1 Intent of this Bid call is to obtain an offer to perform Work, located at 500 Church Street, Penetanguishene ON, L9M 1G3 for Stipulated Price contract, in accordance with Contract Documents.
- .2 Initiate Work within thirty (30) days of receipt of notice of contract award.

1.3 CONTRACT DOCUMENTS IDENTIFICATION

- .1 Contract Documents are identified as Project number 020708.51 as prepared by the Consultant and listed in Table of Contents.

1.4 CONTRACT/BID DOCUMENTS

- .1 Agreement Form.
- .2 Definitions:
 - .1 Contract Document: Defined in CCDC 2, Latest Edition.
 - .2 Bid Document: Contract Documents supplemented with Instructions to bidders and bid Form.
 - .3 Bid, Offer or bidding: act of submitting an offer under seal.
 - .4 Bid Price: Monetary sum identified in bid Form as an offer to perform Work.
- .3 Availability:
 - .1 Electronic versions of bid documents will be provided by the Owner to qualified bidders.
- .4 Queries/Addenda:
 - .1 Direct questions to Materials Management at purchasing@waypointcentre.ca.
 - .2 Addenda may be issued during bidding period. addenda will become part of Contract Documents. Include costs in Bid price.
 - .3 Verbal answers are only binding when confirmed by written addenda.

- .4 Clarifications requested by bidders must be in writing not less than five (5) days before date set for receipt of Bids. Reply will be in form of an addendum. Copy of addendum will be forwarded to known bidders no later than five (5) working days before receipt of Bids.
- .5 Product/System Options:
 - .1 Substituted products will be considered if submitted as an attachment to Bid Form.
 - .2 Ensure submission provides sufficient information to enable Consultant to determine acceptability of such products.
 - .3 Provide complete information on required revisions to other work to accommodate each substitution, dollar amount of additions to or reductions from Bid price, including revisions to other work.
 - .4 Provide specified products unless substitutions are submitted as noted and subsequently accepted.
 - .5 Substitutions:
 - .1 In accordance with Section 01 25 00 - Substitution Procedures and Substitutions will be considered by the Owner if:
 - i. Materials and Products specified in the Contract Documents are not available.
 - ii. Delivery date of material or Product specified would unduly delay the completion of the Contract.
 - iii. The substitute material or product to be considered by the Owner, is comparable or better than the material or Product specified and will result in a credit to the Owner.
 - iv. If in the Owners opinion, the proposed substitution does not meet the requirements of the Contract Documents, the Contractor shall, at no extra cost to the Owner, provide a product which, in the Owner's opinion, does meet the requirements of the Contract Documents. The Owner's decision is final.
 - v. Acceptable products and manufacturers accepted by the Owner shall not be changed without the written approval of the Owner.

1.5 **SITE ASSESSMENTS**

- .1 Site Examination:
 - .1 Visit Project site and surrounding area before submitting Bid.
 - .2 Mandatory visit to Project site has been arranged for bidders as follows:
 - .1 Location: Project site, 500 Church Street, Penetanguishene ON
 - .2 Date: Wednesday the 21st day of February 2024
 - .3 Time; 10:00 a.m.

1.6 **QUALIFICATIONS**

- .1 Subcontractors: Owner reserves right to reject proposed subcontractor for reasonable cause.

1.7 BID SUBMISSION

.1 Bid Ineligibility:

- .1 Bids that are unsigned, improperly signed or sealed, conditional, illegible, obscure, contain arithmetical errors, erasures, alterations or irregularities of any kind, will be declared informal at Owner's discretion.
- .2 Bids with Bid Forms and enclosures which are improperly prepared will be declared informal at Owner's discretion.
- .3 Bids that fail to include security deposit, bonding or insurance requirements will be declared informal at Owner's discretion.
- .4 Bids are by invitation, only from selected bidders. bids from unsolicited bidders will be returned.

.2 Submissions:

- .1 Bidders are solely responsible for delivery of their Bids in manner and time prescribed.
- .2 Improperly completed information, irregularities in Bid Bond, will be cause not to open Bid envelope and declare Bid informal.
- .3 An abstract of submitted Bids will be made available to bidders following Bid opening.

1.8 BID ENCLOSURES/REQUIREMENTS

.1 Security Deposit:

- .1 Bids are to be accompanied by security deposit in an amount not less than 10% of Bid price.
- .2 Endorse bid Bond in name of Owner as obligee, signed and sealed by (Contractor) and surety.
- .3 Use most current edition CCDC approved bond forms.

.2 Agreement to Bond:

- .1 Submit with Bid Form and Bid Bond, Agreement to Bond, stating that surety providing Bid Bond is willing to supply Performance and Labour and Materials Payment Bond specified.
- .2 Include cost of bonds in Bid Price.

.3 Performance Assurance

- .1 Accepted bidder must provide Performance and Labour and Materials Payment Bond as described in Supplementary Conditions.
- .2 Include cost of bonds in Bid Price.

.4 Insurance: Provide signed "Undertaking of Insurance" on standard form provided by insurance company stating intention to provide insurance to bidder in accordance with insurance requirements of Contract Documents.

.5 Bid Form Requirements:

- .1 State in Bid Form, time required to complete Work. Completion date in agreement must be completion time added to commencement date.

- .2 Bidder, in submitting an offer, accepts time period stated in Contract Documents for performing Work. Completion date in agreement is completion time added to commencement date.
- .3 Bidder, in submitting an offer, agrees to complete Work indicated in Contract Documents.
- .4 Consideration will be given to time of completion when reviewing bids submitted.
- .6 Fees for Changes in Work
 - .1 Include in Bid Form, percentage markup for overhead and profit applicable for changes in Work, whether additions to or deductions from Work on which Bid Price is based.
 - .2 Include in Bid Form, fees proposed for subcontract work for changes (both additions and deductions) in Work. Contractor may apply markup as noted, to Subcontractor's gross (net plus markup) costs on additional work.
- .7 Bid Signing:
 - .1 Bid Form to be signed under seal by bidder.
 - .2 Sole Proprietorship: Signature of sole proprietor in presence of witness who shall also sign. Insert words "Sole Proprietor" under signature. Affix seal.
 - .3 Partnership: Signature of partners in presence of witness who shall also sign. Insert word 'Partner' under each signature. Affix seal to each signature.
 - .4 Limited Company: Signature of duly authorized signing officer(s) in normal signatures. Insert officer's capacity in which signing officer acts, under each signature. If Bid is signed by officials other than president and secretary of company or president-secretary-treasurer of company, copy of by-law resolution of board of directors authorizing them to do so must also be submitted with Bid.
 - .5 Incorporated Company: Signature of duly authorized signing officer(s) in normal signatures. Insert officer's capacity in which signing officer acts, under each signature. If Bid is signed by officials other than president and secretary of company or president-secretary-treasurer of company, copy of by-law resolution of board of directors authorizing them to do so must also be submitted with Bid in Bid envelope.
- .8 Appendices to Bid Form:
 - .1 Appendix A - Contract Documents: Include complete listing of documents and information issued by which Bid price was derived, complete listing as scheduled in Contract Documents.
 - .2 Appendix C - Unit Prices: Include listing of unit prices specifically requested in Bid Documents.
- 1.9 **OFFER ACCEPTANCE/ REJECTION**
 - .1 Duration of Offer: Bids to remain open to acceptance and irrevocable for ninety (90) days after bid closing date.
 - .2 Bid Determination:
 - .1 The low bid shall be determined using the "base bid plus" approach, as outlined in CCDC 23.

- .2 Determination of the low bid follows industry guidance document and ensures that fundamental principles of a fair, open, competitive and transparent process are upheld.
- .3 Acceptance of Offer:
 - .1 Owner reserves right to accept or reject any or all offers.
 - .2 After acceptance by Owner, Consultant will issue to successful bidder, written Bid acceptance.
- Part 2 Products – Not Used
- Part 3 Execution – Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **EXISTING HAZARDOUS MATERIAL INFORMATION**

- .1 This Document with its referenced attachments is part of the Procurement and Contracting Requirements for the Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments do not form part of the Contract Documents.
- .2 An existing electronic asbestos report for this Project, is available upon request..

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

The following supplementary conditions to the CCDC 2-2020 Stipulated Price Contract have been developed in consultation and agreement with the Ontario General Contractors Association (OGCA) and are in alignment with supplementary conditions that have been established previously in consultation with specific owner groups and industry partners. This document updates the previous supplementary conditions document which was jointly developed for use with CCDC 2-2008. Revisions to this document are indicated by a vertical bar in the right margin of the paragraph where the revision was made.

The OGCA has issued this same set of supplementary conditions to their members with the advice that they have been developed in consultation with the Ontario Association of Architects (OAA).

Supplementary Conditions for the Stipulated Price Contract – CCDC 2-2020 September 15, 2021 (Revised February 10, 2022)

The Standard Construction Document for CCDC 2 Stipulated Price Contract, 2020 English version, consisting of the Agreement Between *Owner* and *Contractor*, Definitions, and General Conditions of the Stipulated Price Contract, Parts 1 to 13 inclusive, governing same is hereby made part of these *Contract Documents*, with the following amendments, additions and modifications. Where these amendments, additions, and modifications specifically reference a change to the Agreement, Definitions, or General Conditions, these amendments, additions and modifications shall govern.

Where a General Condition or paragraph of the General Conditions of the Stipulated Price Contract is deleted by these Supplementary Conditions, the numbering of the remaining General Conditions or paragraphs shall remain unchanged, and the numbering of the deleted item will be retained, unused

AMENDMENTS TO AGREEMENT

ARTICLE A-5 – PAYMENT

- .1 In paragraph 5.1.1 of Article A-5 add the following words to the end:
“or, where there is no *Payment Certifier*, jointly by the *Owner* and *Contractor*”

ARTICLE A-6 – RECEIPT AND ADDRESSES FOR NOTICES IN WRITING

- .1 Delete paragraph 6.5 of Article A-6 in its entirety and replace it with the following:
“6.5 Contact information for a party may be changed by *Notice in Writing* to the other party setting out the new contact information in accordance with this Article.”

AMENDMENTS TO DEFINITIONS

- .1 Add the following definition: Proper Invoice

“*Proper Invoice* means a “proper invoice” as defined in the *Payment Legislation*, if any, and as may be modified by written agreement between the parties to the extent permitted by such *Payment Legislation*.”
- .2 Add the following definition: Submittals

“*Submittals* are documents or items required by the *Contract Documents* to be provided by the *Contractor* such as:
 - *Shop Drawings*, samples, models, mock ups to indicate details or characteristics, before the portion of the *Work* that they represent can be incorporated into the *Work*, and
 - As-built drawings and manuals to provide instructions to the operation and maintenance of the *Work*.”

SUPPLEMENTARY CONDITIONS

PART 1 GENERAL PROVISIONS GC 1.1 CONTRACT DOCUMENTS

- .1 Delete paragraphs 1.1.3 and 1.1.4 in their entirety and replace them with the following:
 - “1.1.3 The *Contractor* shall review the *Contract Documents* for the purpose of facilitating and co-ordination and execution of the *Work* by the *Contractor*. The *Contractor* shall report promptly to the *Consultant* any ambiguities, design issues or other matters requiring clarification made known to the *Contractor* or that the *Contractor* may discover from such a review. Such review by the *Contractor* shall comply with the standard of care described in paragraph 3.9.1 of the *Contract*.
 - 1.1.4 Except for its obligation to review the *Contract Documents* and report the result pursuant to paragraph 1.1.3, the *Contractor* is not responsible for ambiguities, design issues or other matters requiring clarification in the *Contract Documents* and does not assume any responsibility to the *Owner* or to the *Consultant* for the accuracy of the *Contract Documents*. Without limiting the foregoing, the *Contractor* shall not be liable for any damages or costs resulting from any ambiguities, design issues or other matters requiring clarification in the *Contract Documents* which the *Contractor* could not reasonably have discovered from such a review in accordance with the standard of care. If the *Contractor* does discover any ambiguities, design issues or other matters requiring clarification in the *Contract Documents*, the *Contractor* shall not proceed with the work affected until the *Contractor* has received modified or additional information from the *Consultant*. The impacts of any ambiguities, design issues or other matters requiring clarification in the *Contract Documents*, including to the *Contract Price* and *Contract Time*, shall be addressed by the parties in accordance with Part 6 – CHANGES.”
- .2 Add the following to the end of subparagraph 1.1.6.2:

“Except to the extent the *Consultant* is indemnified as a third party beneficiary as provided in subparagraphs 9.2.7.4 and 9.5.3.4 and in paragraph 13.1.3.”

PART 2 ADMINISTRATION OF THE CONTRACT

GC 2.2 ROLE OF THE CONSULTANT

- .1 In paragraph 2.2.3 add the following to the end:

“Without limiting the foregoing, the *Consultant* may appoint one or more authorized representatives in writing who may fulfill the obligations of the *Consultant* under this *Contract*.”
- .2 In paragraph 2.2.8 add the words “, written statements” after the word “interpretations” in both the first and second sentences; and
 - i. add the following to the end of paragraph 2.2.8:

“The *Owner* and the *Contractor* shall waive any claims against the *Consultant* arising out of its making of any interpretations, written statements or findings in accordance with paragraphs 2.2.6, 2.2.7, 2.2.8, and 7.1.2, but only to the extent that any such interpretations, written statements, and findings are made by the *Consultant* in an unbiased manner, and in accordance with the *Consultant*’s professional standard of care at law.”
- .3 In paragraph 2.2.13 add the words “which are provided” before the words “by the *Contractor*”.

GC 2.4 DEFECTIVE WORK

- .1 In paragraph 2.4.1:
 - i. Add after the words “shall promptly correct” the phrase “in a manner acceptable to the *Owner* and the *Consultant*”; and
 - ii. Add after the words “*Contract Documents*” the phrase “or work that the *Contractor* discovers to be defective, whether or not the defective work had been identified by the *Consultant*, and”.
- .2 Add new paragraph 2.4.4 as follows:

“2.4.4 The *Contractor* shall prioritize the correction of any defective work which, in the sole discretion of the *Owner*, adversely affects the day-to-day operation of the *Owner*.”

PART 3 EXECUTION OF THE WORK

GC 3.1 CONTROL OF THE WORK

- .1 Add new paragraph 3.1.3 as follows:

“3.1.3 Prior to commencing individual procurement, fabrication and construction activities, the *Contractor* shall verify, at the *Place of the Work*, all relevant measurements and levels necessary for proper and complete fabrication, assembly and installation of the *Work* and shall further carefully compare such field measurements and conditions with the requirements of the *Contract Documents*. Where dimensions are not included or contradictions exist, or exact locations are not apparent, the *Contractor* shall immediately notify the *Consultant* in writing and obtain written instructions from the *Consultant* before proceeding with any part of the affected work.”

GC 3.2 CONSTRUCTION BY OWNER AND OTHER CONTRACTORS

- .1 Add new paragraph 3.2.7 as follows:

“3.2.7 At the commencement of the *Work*, the *Contractor* shall prepare for the review and acceptance of the *Owner* and the *Consultant*, a schedule indicating the times, within the construction schedule referred to in GC 3.4, that items that are specified to be *Owner* purchased and *Contractor* installed or hooked up are required at the site to avoid delaying the progress of the *Work*.”

GC 3.7 LABOUR AND PRODUCTS

- .1 Add the following to the end of paragraph 3.7.1:
“The *Contractor* represents that it has sufficient skilled employees to replace, subject to the *Owner*’s approval, acting reasonably, its designated supervisor and project manager in the event of death, incapacity, removal or resignation.”
- .2 Add new paragraphs 3.7.4 and 3.7.5 as follows:
“3.7.4 The *Owner* shall provide the *Contractor* in a timely manner with all relevant information (including storage, protection, and installation requirements) regarding *Products* to be supplied by the *Owner* or other contractors and, prior to delivery of any such *Products* to the *Place of the Work*, the *Owner* shall obtain the *Contractor*’s written approval of the delivery date and proposed storage, protection and installation requirements.
3.7.5 Once the *Contractor* has accepted delivery of *Products*, the *Contractor* shall be responsible for the safe storage and protection of *Products* as required to avoid dangerous conditions or contamination to the *Products* or other persons or property. *Products* shall be stored in locations and at the *Place of the Work* to the satisfaction of the *Owner* and the *Consultant* as agreed and approved by the *Contractor* pursuant to paragraph 3.7.4.
Notwithstanding the foregoing, the *Contractor* shall not be responsible for any *Products* supplied by the *Owner* or other contractors unless:
(i) the *Contract Documents* expressly stipulate that such *Product* is to be the *Contractor*’s responsibility and to be installed by the *Contractor* as part of the
Work;
(ii) the *Contractor* has or has received from the *Owner* proof of insurance coverage sufficient, at a minimum, to cover the replacement cost of such *Product*; and
(iii) the *Owner* obtained the *Contractor*’s approval as required by paragraph 3.7.4.”

GC 3.8 SHOP DRAWINGS

- .1 Add the words “AND OTHER SUBMITTALS” to the title of GC 3.8 after the words “SHOP DRAWINGS”.
- .2 Add the words “and *Submittals*” after the words “*Shop Drawings*” in paragraphs 3.8.1, 3.8.2, 3.8.3, 3.8.3.2, 3.8.5, 3.8.6, and 3.8.7.
- .3 Delete paragraph 3.8.2 in its entirety and replace it with new paragraph 3.8.2 as follows:
“3.8.2 Prior to the first application for payment, the *Contractor* and the *Consultant* shall jointly prepare a schedule of the dates for submission and return of *Shop Drawings* and *Submittals* in an orderly sequence.”
- .4 Delete the words “with reasonable promptness so as to cause no delay in the performance of the *Work*” and replace them with the words “within 10 *Working Days* or such longer period as may be reasonably required” in paragraph 3.8.7.

GC 3.9 PERFORMANCE BY CONTRACTOR

- .1 Add new General Condition GC 3.9 as follows:

"GC 3.9 PERFORMANCE BY CONTRACTOR

- 3.9.1 In performing its services and obligations under the *Contract*, the *Contractor* shall exercise
- a
- standard of care, skill and diligence that would normally be provided by an experienced and prudent contractor supplying similar services for similar projects. The *Contractor* acknowledges and agrees that throughout the *Contract*, the *Contractor's* obligations, duties and responsibilities shall be interpreted in accordance with this standard. The *Contractor* shall exercise the same standard of due care and diligence in respect of any *Products*, personnel, or procedures which it may recommend to the *Owner*."

PART 4 ALLOWANCES

GC 4.1 CASH ALLOWANCES

- .1 Delete paragraph 4.1.7 in its entirety and replace it with the following:
- "4.1.7 At the commencement of the *Work*, the *Contractor* shall prepare for the review and acceptance of the *Owner* and the *Consultant* a schedule indicating the times within the construction schedule referred to in GC 3.4 that items called for under cash allowances are required to be delivered to the *Place of the Work* to avoid delaying the progress of the *Work*."
- .2 Add new paragraph 4.1.8 as follows:
- "4.1.8 The *Owner* reserves the right to call, or to have the *Contractor* call, for competitive bids for portions of the *Work* to be paid for from cash allowances."

PART 5 PAYMENT

GC 5.4 PAYMENT OF HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF THE WORK

- .1 Delete all paragraphs of GC 5.4 in their entirety and replace them with the following paragraphs:
- "5.4.1 When the *Contractor* considers that the *Work* is substantially performed, or if permitted by the lien legislation applicable to the *Place of the Work* a designated portion thereof which the *Owner* agrees to accept separately is substantially performed, the *Contractor* shall, within five (5) *Working Days*, deliver to the *Consultant* and to the *Owner* a comprehensive list of items to be completed or corrected, together with a written application for a review by the *Consultant* to establish *Substantial Performance of the Work* or substantial performance of the designated portion of the *Work*. Failure to include an item on the list does not alter the responsibility of the *Contractor* to complete the *Contract*.
- 5.4.2 The *Consultant* will review the *Work* to certify or verify the validity of the application and shall promptly, and in any event, no later than 10 calendar days after receipt of the *Contractor's* application:
- .1 advise the *Contractor* in writing that the *Work* or the designated portion of the *Work* is not substantially performed and give reasons why, or
- .2 state the date of *Substantial Performance of the Work* or a designated portion of the *Work* in a certificate and issue a copy of that certificate to each of the *Owner* and the *Contractor*.
- 5.4.3 Where the holdback amount required by the applicable lien legislation has not been placed in a separate lien holdback account, the *Owner* shall, no later than

- 10 calendar days prior to the expiry of the holdback period stipulated in the lien legislation applicable to the *Place of the Work*, place the holdback amount in a bank account in the joint names of the *Owner* and the *Contractor*.
- 5.4.4 Subject to the requirements of any *Payment Legislation*, all holdback amounts prescribed by the applicable lien legislation for the *Place of the Work* shall become due and payable to the *Contractor* no later than 10 *Working Days* following the expiration of the holdback period stipulated in the lien legislation applicable to the *Place of the Work*, as certified or verified by the *Consultant* when permitted by any *Payment Legislation*.
- 5.4.5 The *Contractor* shall submit an application for release of the lien holdback amount in accordance with the lien legislation applicable to the *Place of the Work*. Except to the extent required by any *Payment Legislation*, such application for release of the holdback shall not constitute an application for payment that is subject to *Proper Invoice* requirements.
- 5.4.6 Where legislation permits progressive release of the holdback for a portion of the *Work* and the *Consultant* has certified or verified that the part of the *Work* has been performed prior to *Substantial Performance of the Work*, the *Owner* hereby agrees to release, and shall release the holdback for such portion of the *Work* to the *Contractor* in accordance with such legislation.
- 5.4.7 Notwithstanding any progressive release of the holdback, the *Contractor* shall ensure that such parts of the *Work* are protected pending the issuance of a final certificate for payment or until the *Owner* takes early occupancy in accordance with GC12.2, whichever comes first, and shall be responsible for the correction of defects or work not performed regardless of whether or not such was apparent when the holdback was released."

GC 5.5 FINAL PAYMENT

- .1 Add to the end of paragraph 5.5.1 the following sentence:
"The application for final payment shall meet the requirements of a *Proper Invoice*."
- .2 Add the following to the end of paragraph 5.5.3:
"Subject to any *Payment Legislation*, when the *Consultant* finds the *Contractor's* application for final payment to be not valid, the *Contractor* shall revise and resubmit the application when the *Contractor* has addressed the reasons given by the *Consultant*."

PART 6 CHANGES IN THE WORK

GC 6.3 CHANGE DIRECTIVE

- .1 Delete the word "and" from the end of subparagraph 6.3.7.18.
- .2 Delete the period from the end of subparagraph 6.3.7.19 and replace it with ";
- and".
- .3 Add new subparagraph 6.3.7.20 as follows:
".20 safety measures and requirements."

GC 6.4 CONCEALED OR UNKNOWN CONDITIONS

- .1 Add new paragraph 6.4.5:
"6.4.5 The *Contractor* confirms that, prior to bidding the *Project*, it carefully reviewed the *Place of the Work* and applied to that review the degree of care and skill described in paragraph 3.9.1, given the amount of time provided between the issue of the bid documents and the actual closing of bids, the degree of access provided to the *Contractor* prior to submission of bid, and the sufficiency and

completeness of the information provided by the *Owner*. The *Contractor* is not entitled to compensation or to an extension of the *Contract Time* for conditions which could reasonably have been ascertained by the *Contractor* by such review undertaken in accordance with this paragraph 6.4.5.”

GC 6.6 CLAIMS FOR A CHANGE IN CONTRACT PRICE

- .1 Add the words “as noted in paragraph 6.6.3” after the words “of the claim” in paragraph 6.6.5 and add the words “and the *Consultant*”, at the end of paragraph 6.6.5.

PART 8 DISPUTE RESOLUTION

GC 8.3 ADJUDICATION

- .1 Delete the word “prescribed” from paragraph 8.2.1 and substitute the words “provided for”.

GC 8.3 NEGOTIATION, MEDIATION AND ARBITRATION

- .1 Add the following new paragraphs 8.3.9 to 8.3.13:
“8.3.9 Within five days of receipt of the notice of arbitration by the responding party under paragraph 8.3.6, the *Owner* and the *Contractor* shall give the *Consultant* a written notice containing:
 - .1 a copy of the notice of arbitration;
 - .2 a copy of supplementary conditions 8.3.9 to 8.3.14 of this *Contract*, and;
 - .3 any claims or issues which the *Contractor* or the *Owner*, as the case may be, wishes to raise in relation to the *Consultant* arising out of the issues in dispute in the arbitration.”

- 8.3.10 The *Owner* and the *Contractor* agree that the *Consultant* may elect, within ten days of receipt of the notice under paragraph 8.3.9, to become a full party to the arbitration under paragraph 8.3.6 if the *Consultant*:
- .1 has a vested or contingent financial interest in the outcome of the arbitration;
 - .2 gives the notice of election to the *Owner* and the *Contractor* before the arbitrator is appointed;
 - .3 agrees to be a party to the arbitration within the meaning of the rules referred to in paragraph 8.3.6, and,
 - .4 agrees to be bound by the arbitral award made in the arbitration.
- 8.3.11 Without limiting and subject to the *Owner* and *Contractor's* rights under paragraph 8.3.12 to challenge whether the *Consultant* has satisfied the requirements of paragraph 8.3.10, if an election is made under paragraph 8.3.10:
- .1 the *Owner* or *Contractor* may request particulars and evidence of the *Consultant's* vested or contingent financial interest in the outcome of the arbitration;
 - .2 the *Consultant* shall participate in the appointment of the arbitrator; and,
 - .3 notwithstanding the rules referred to in paragraph 8.3.6, the time period for reaching agreement on the appointment of the arbitrator shall begin to run from the date the respondent receives a copy of the notice of arbitration.
- 8.3.12 The arbitrator in the arbitration in which the *Consultant* has elected under paragraph 8.3.10 to become a full party may:
- .1 on application of the *Owner* or the *Contractor*, determine whether the *Consultant* has satisfied the requirements of paragraph 8.3.10, and;
 - .2 make any procedural order considered necessary to facilitate the addition of the *Consultant* as a party to the arbitration.
- 8.3.13 The provisions of paragraph 8.3.9 shall apply (with all appropriate changes being made) to written notice to be given by the *Consultant* to any sub-consultant."

PART 9 PROTECTION OF PERSONS AND PROPERTY

GC 9.1 PROTECTION OF WORK AND PROPERTY

- .1 Delete subparagraph 9.1.1.1 in its entirety and replace it with the following:
 - "1 errors or omissions in the *Contract Documents* which the *Contractor* could not have discovered applying the standard of care described in paragraph 3.9.1;"
- .2 Delete paragraph 9.1.2 in its entirety and replace it with the following:
 - "9.1.2 Before commencing any *Work*, the *Contractor* shall determine the locations of all underground utilities and structures indicated in the *Contract Documents*, or that are discoverable by applying to an inspection of the *Place of the Work* the degree of care and skill described in paragraph 3.9.1."

GC 9.2 TOXIC AND HAZARDOUS SUBSTANCES

- .1 Add the following words to paragraph 9.2.6 after the word "responsible":

"or whether any toxic or hazardous substances or materials already at the *Place of the Work* (and which were then harmless or stored, contained or otherwise dealt with in accordance with legal and regulatory requirements) were dealt with by the *Contractor* or anyone for whom the *Contractor* is responsible in a manner which does not comply with legal and regulatory requirements, or which threatens human health and safety or the environment, or material damage to the property of the *Owner* or others,"
- .2 Add the words "and the *Consultant*" after the word "*Contractor*" in subparagraph 9.2.7.4.
- .3 Add the following words to paragraph 9.2.8 after the word "responsible":

"or that any toxic or hazardous substances or materials already at the *Place of the Work* (and which were then harmless or stored, contained or otherwise dealt with in accordance with legal and regulatory requirements) were dealt with by the *Contractor* or anyone for whom the *Contractor* is responsible in a manner which does not comply with legal and regulatory requirements, or which threatens human health and safety or the environment, or material damage to the property of the *Owner* or others,"

GC 9.5 MOULD

- .1 Add the words "and the *Consultant*" after the word "*Contractor*" in subparagraph 9.5.3.4.

PART 10 GOVERNING REGULATIONS

GC 10.2 LAWS, NOTICES, PERMITS, AND FEES

- .1 Delete from the first line of paragraph 10.2.5 the word, "The" and substitute the words "Subject to paragraph 3.9.1, the".

PART 12 OWNER TAKEOVER

GC 12.1 READY-FOR-TAKEOVER

- .1 After the second occurrence of the term "*Ready-for-Takeover*" insert before the term "*Readyfor-Takeover*" in paragraph 12.1.3 the words "determination of".

GC 12.2 EARLY OCCUPANCY BY THE OWNER

- .1 Delete the word "achieve" in paragraph 12.2.4 and replace it with the words "have achieved".

GC 12.3 WARRANTY

- .1 Delete the word "The" from the first line of paragraph 12.3.2 and replace it with the words "Subject to paragraph 3.9.1, the".

PART 13 INDEMNIFICATION AND WAIVER

GC 13.1 INDEMNIFICATION

- .1 Add new paragraph 13.1.0 as follows:

“13.1.0 The *Contractor* shall indemnify and hold harmless the *Consultant*, its agents and employees from and against all claims, demands, losses, costs, damages, actions, suits, or proceedings by third parties that arise out of, or are attributable to the *Contractor's* performance of the *Contract*, provided such claims are:

 - .1 attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property, and
 - .2 caused by negligent acts or omissions of the *Contractor* or anyone for whose negligent acts or omissions the *Contractor* is liable, and
 - .3 made by *Notice in Writing* within a period of 6 years from the *Ready-forTakeover* date or within such shorter such period as may be prescribed by any limitation statute or the Province or Territory of the *Place of Work*.”
- .2 Add the words “13.1.0,” after the word “paragraphs” in paragraph 13.1.3.

[End of recommended supplementary conditions]

Part 1 General

1.1 **INTENT**

- .1 This Section outlines the General Requirements that shall be administered by the Contractor. While the Specification Section establishes the requirements for each trade, the Contractor shall directly supervise and administer Contract requirements to ensure the provision of materials, labour and equipment necessary to complete the Work on time and to the quality specified.

1.2 **CONTRACT**

- .1 The successful contractor will be required to execute the Canadian Standard Construction Document for Stipulated Price Contract, CCDC 2-2008, as amended by the Supplementary Conditions.
- .2 Contractors will be required to sign a standard confidentiality agreement prior to commencing Work.

1.3 **WORK RESTRICTIONS**

- .1 The Waypoint Centre for Mental Health Care is a high security psychiatric hospital and security is a priority issue.
- .2 Work hours shall be restricted to between 08:00 am and 05:00 pm. Work outside of these hours will only be permitted provided it has been approved in advance by the Project Manager.
- .3 Individuals on the Project site shall sign in and receive a Waypoint contractors identification badge. I.D. badges are not permitted to leave the Project site at any time. Individuals must sign out at the end of each Working Day.
- .4 Waypoint has a strict non fraternization policy. Contractors, Subcontractors and their workers are expected to be courteous to Waypoint staff and patients, however under no circumstances shall they engage in conversations, dialogue, or other form(s) of personal relationship(s) on the Project site.
- .5 Waypoint is a non-smoking facility. Smoking on the property is strictly forbidden.

1.4 **ALTERNATIVES**

- .1 Substitutions will be considered by the Owner if:
 - .1 Materials and products specified in the Contract Documents are not available.
 - .2 Delivery date of material or specified Product would unduly delay the completion of the Contract.
 - .3 The substitute material or product to be considered by the Owner, is comparable or better than the material or specified Product and will result in a credit to the Owner.
 - .4 If in the Owners opinion, the proposed substitution does not meet the requirements of the Contract Documents, the Contractor shall, at no extra cost to the Owner, provide a product which, in the Owner's opinion, does meet the requirements of the Contract Documents. The Owner's decision is final.
- .2 Acceptable Products and manufacturers accepted by the Owner shall not be changed without the written approval of the Owner.

1.5 PAYMENT

- .1 Contractors may submit applications for payment monthly.
- .2 Payments are subject to the Owner's review and acceptance as well as a 10% holdback in accordance with the Construction Lien Act.
- .3 Release of holdback requires the Contractor advertise substantial performance in accordance with the Act.

1.6 WORK SCHEDULE

- .1 The Contractor agrees that time shall be of the essence in the performance of the Contractor's obligations under this Contract. Within ten (10) days of receipt of the award letter, prepare and submit a detailed Work Schedule, clearly showing the anticipated progress stages, start and finish date of each construction phase and date of final completion of the Work.
- .2 On approval of the Work Schedule by the Owner, proceed to ensure completion of Work within the scheduled time.
- .3 Carry out Work in a continuous manner. If at any time one (1) phase falls behind schedule, take necessary measures to expedite subsequent phases to maintain or improve on completion date.

1.7 SUBMITTALS

- .1 Submittals of required Shop Drawings, samples, etc. shall be made directly to the Consultant with a copy of the transmittal sent to the Owner for tracking purposes.

1.8 HEALTH AND SAFETY

- .1 Abide by the provisions of acts, regulations pertaining to health and safety including Occupational Health and Safety Act R.S.O. 1980 Chapter 312 and Amendments, Ontario Regulation 214/91 and Amendments, Workplace Hazardous Materials Information System (WHMIS) regulation, Ontario Regulation 644/88.
- .2 File notice of Project with provincial authorities prior to beginning Work.
- .3 The Contractor shall, upon request, submit to the Owner the following documentation:
 - .1 A copy of the Contractors Health and Safety Policy.
 - .2 Copies of incident and/or accident reports.
 - .3 Copies of reports issued by agency having jurisdiction (AHJ) (i.e.: Ministry of Labour).
 - .4 Minutes of Contractors health and safety meetings
 - .5 Certificates/Confirmation of training of on-site staff (i.e.: fall protection; confined space; first aid; etc.).
 - .6 Material safety data sheets (MSDS) for material used and/or stored on Waypoint's site.
- .4 Be responsible for health and safety of persons on the Project site, safety of property on site and for protection of persons adjacent to the Project site and environment to extent that they may be affected by conduct of the Work.

1.9 SITE SAFETY/CODE RESPONSE

- .1 Contractor, Subcontractors, and workers on the Project site should be familiar with the Waypoint emergency code system and the how to respond in the event of a code.
- .2 Codes and recommended response are as follows:
- .3 CODE WHITE (Violent or Behavioral Situation):
 - .1 Should a CODE WHITE be announced over the public address system, Contractors and their workforce are expected to cease work and await direction from Waypoint staff. Work may be resumed upon an announcement that the CODE WHITE has ended.
 - .2 In the event that the Contractor or individual(s) on the Project site feels threatened or witnesses violent behavior dial 3333 from the nearest phone clearly stating CODE WHITE and provide worksite location including building and floor location. Await further direction from Waypoint staff.
- .4 CODE GREEN (Evacuation): In the event of a Code Green the Contractor and their workforce are directed to immediately vacate the site and await direction for Waypoint Staff.
- .5 CODE Blue, Yellow, Brown, Purple, Black, Grey or Silver: In the event that any of the above occur the Contractor and their workforce are directed to stand down and await further direction from Waypoint staff.

1.10 FIRE SAFETY

- .1 Parties on the Project site should know location of nearest fire alarm box, key station, and telephone, including emergency phone number. Know the location of the work site including municipal address, building name and number, and floor location
- .2 Report immediately fire incidents to fire department as follows:
 - .1 Activate nearest fire alarm pull station, key station and evacuate area.
 - .2 Dial 3333 from the nearest phone clearly stating CODE RED and provide worksite location including building and floor location.
 - .3 Fire protection systems shall remain operational unless a shut off has been coordinated in advance with the Owner's representative.
 - .4 Fire protection and alarm systems will not be:
 - .1 obstructed;
 - .2 shut off; and left inactive at end of Working Day or shift without authorization from the Owner.
- .3 Fire hydrants, standpipes and hose systems will not be used for other than firefighting purposes unless authorized by the Owner.
- .4 Hot work, i.e. welding, cutting, soldering, grinding or other activity that generates heat or smoke are to be identified and scheduled appropriately before work is performed. Coordinated with the Project Manager. Smoke covers must be used at all times.
- .5 Advise the Owner of work that would impede fire routes and/or apparatus response. This includes violation of minimum overhead clearance, as prescribed by the fire chief, erecting of barricades and digging of trenches.
- .6 Provide and maintain in working order suitable ULC fire extinguishers located in suitable positions to the approval of AHJ.

1.11 ENVIRONMENTAL

- .1 Asbestos containing materials are present in a number of Waypoint buildings.
- .2 Contractors and Subcontractors and their workforce shall review locations of asbestos containing materials by consulting documentation and survey reports on the Project site.
- .3 There is to be no removal or disturbing of asbestos containing materials unless appropriate measures are followed and the persons doing this work are appropriately trained and in compliance with asbestos in construction related materials.
- .4 In the event that the Contractor encounters suspected asbestos containing material, stop work and advise the Owner immediately. Re-commencement of work will not be permitted until such a time as the Owner has confirmed that it is safe to do so.

1.12 CONSTRUCTION FACILITIES

- .1 Provide fencing or a similar style barrier around work site to clearly define extent of work and to prevent unauthorized entry to the Project site.
- .2 Prior to the commencement of work anticipated to generate dust in any form (e.g., general construction, demolition, plastering and sanding, installation of non-asbestos containing ceiling tiles, etc.) in occupied areas, the Contractor shall carry out work in accordance with Waypoint guidelines and in such a manner as to have the least impact on building occupants.
- .3 Erect a 'dust barrier' around the perimeter of the work site, using a minimum 6 mil plastic, tape and framing as necessary, to complete a tight seal from floor to ceiling. Entry point(s) will have a "zippered door" of similar material that is to be kept closed at all times during Work.
- .4 Ensure that the air circulation system has been shut down and/or air vents/return plenums sealed off as indicated in preparation for start-up.
- .5 Park only in areas designated by Project Manager.
- .6 Use of Waypoint facilities (washrooms, cafeteria, etc.) will be established at the outset of the Work and only be permitted as designated by the Project Manager.
- .7 Ensure that air circulation within the construction area, is completely vented to the exterior. No air from the construction area, will be permitted to migrate anywhere outside the construction area and into other areas of the building.

1.13 PROJECT MEETINGS

- .1 The Owner will call an initial Project meeting.
- .2 The agenda of the briefing meeting will include:
 - .1 Introducing key personnel participating in the Project.
 - .2 Establishing limits on work hours, access, movements on the Project site, etc.
 - .3 Reviewing the approved Work Schedule.
 - .4 Establishing administrative and procedural matters.
 - .5 Establishing the schedule for Project meetings.
 - .6 And other items as necessary.
- .3 The Contractor shall record minutes, include decisions and identify action required by parties.

- .4 Reproduce and distribute copies of minutes within three (3) days to participants and the Owner.

1.14 **LAYOUT OF WORK**

- .1 Be responsible for layout of parts of the Work in accordance with lines, levels, elevations and measurements shown on the Drawings.
- .2 Errors resulting from failure to verify figures or the proper lay out of any element of the installation shall be rectified without additional cost.

1.15 **STANDARDS**

- .1 Work shall be carried out in accordance with the Ontario Building Code (Ont Reg. 350/06).

1.16 **AS BUILT DRAWINGS AND MANUALS**

- .1 Record and maintain as built drawings, containing operation and maintenance information on an ongoing basis during the work.
- .2 Submit one (1) draft copy of as built drawings and operating and maintenance manuals for review.
- .3 Upon acceptance of the draft, assemble and forward two (2) additional copies of "As Built" drawings, maintenance and operating manuals prior to application of final payment.

1.17 **WARRANTIES**

- .1 Expedite the preparation and submission of warranties, particularly extended period warranties, as specified. In general, the Contractor shall warrant all aspects of the Project for a period of one (1) year, following substantial completion, unless specified otherwise. The structure shall be warranted for a period of five (5) years.

1.18 **CLEANING**

- .1 Maintain a clean Project site and building, remove waste materials, debris from the Project site at regular intervals and deposit in designated containers.
- .2 Upon completion engage the services of a professional cleaning company to clean the facility including, but not limited to, fixtures, fittings and surfaces (including windows), etc.

Part 2 Products - Not used.

Part 3 Execution - Not used.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **WORK OF THE PROJECT**

- .1 Work of the Project, of which Work of this Contract is a part, comprises the following:
 - .1 Waypoint Centre for Mental Healthcare is a campus located off Georgian Bay in Penetanguishene, ON. The Work is to be completed on Level Three of the Toanche Building (one [1] of multiple buildings on campus). The Toanche Building was completed in the early 1970's and is constructed with concrete floors and precast exterior walls, interior walls are predominantly concrete block. The renovation Project is to erect a twenty (20) bed acute mental health patient floor on Level 03 of the building. The current floor is unoccupied. The Project consists of patient bedrooms, activity areas and nurse control points/ care desks. There will be mechanical, electrical tie-ins to existing infrastructure. The Project area is approximately 1021.93 m² (11,000 ft²) of floor area.
 - .2 Municipal Address: 500 Church Street, Penetanguishene ON, L9M 1G3

1.2 **DIVISION OF WORK**

- .1 Division of the Work among Subcontractors and Suppliers is solely Contractor's responsibility. Consultant and Owner assume no responsibility to act as an arbiter to establish subcontract limits between sections or divisions of the work.

1.3 **SPECIFICATIONS LANGUAGE AND STYLE**

- .1 These Specifications are written in the imperative mood and in streamlined form. The imperative language is directed to Contractor, unless stated otherwise.
- .2 Complete sentences by reading "shall", " Contractor shall", "shall be" and similar phrases by inference. Where a colon (:) is used within sentences and phrases, read the words "shall be" by inference.
- .3 Fulfill and perform indicated requirements whether stated imperatively or otherwise.
- .4 When used in the context of a Product, read the word "provide" to mean "supply and install to result in a complete installation ready for its intended use".

1.4 **CONTRACT DOCUMENTS FOR CONSTRUCTION PURPOSES**

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

1.5 **DOCUMENTS AT THE SITE**

- .1 Keep the following documents at Place of the Work, stored securely and in good order and available to Owner and Consultant in hard copy and electronic form:
 - .1 Current Contract Documents, including Drawings, Specifications and addenda.
 - .2 Change Orders, Change Directives and Supplementary Instructions.
 - .3 Reviewed Shop Drawings, Product data and samples.
 - .4 Field test reports and records.
 - .5 Construction progress schedule.

- .6 Meeting minutes.
- .7 Manufacturer's certifications.
- .8 Permits, inspection certificates and other documents required by authorities having jurisdiction (AHJ).
- .9 Current as-built drawings.
- .10 Material Safety Data Sheets (MSDS) for controlled Products.

1.6 **CONTRACTOR'S USE OF PREMISES**

- .1 Except as otherwise specified, Contractor has unrestricted use of Place of the Work from time of Contract award until Substantial Performance of the Work.
- .2 Confine Construction Equipment, Temporary Work, storage of Products, waste products and debris and other construction operations to limits required by laws, ordinances, permits and Contract Documents, whichever is most restrictive. Do not unreasonably encumber Place of the Work.
- .3 Contractor to provide a defined area outside of the building, for secure material storage.
- .4 Contractor to provide a secure perimeter, to be reviewed and approved by the Owner.

Part 2 Products - Not used.

Part 3 Execution - Not used.

END OF SECTION

Part 1 General

1.1 **SUMMARY OF CONTRACTUAL RELATIONSHIPS**

- .1 This Section specifies administrative provisions related to the exercise of Owner's right to assign the Contract to another contractor ("prime contractor").
- .2 Upon award of the Contract, Contractor shall execute an agreement with Owner for performance of the Contract.
- .3 At a later date, Owner will enter into an agreement with prime contractor for performance of prime contract, the terms of which provide for the assignment of the Contract to prime contractor.
- .4 Owner intends to exercise its right under the Contract to assign the Contract to prime contractor, with Contractor's written consent by means of an assignment agreement in the form provided in Section 00 73 26 – Assignment Agreement.
- .5 Upon assignment of the Contract, Contractor shall become a subcontractor to prime contractor as set out in the assignment agreement.

1.2 **PRIME CONTRACT AND PRIME CONTRACTOR**

- .1 Prime Contractor: To be determined upon award of the prime contract.

1.3 **ASSIGNMENT OF CONTRACT**

- .1 Project schedule calls for the prime contract to be awarded within one hundred twenty (120) days after the Tender. Schedule is subject to change.
- .2 Contractor will be named as a "designated Subcontractor" and the Contract will be called an "assignable contract" in the Contract Documents for the prime contract.
- .3 The cost of the Contract will be included in the prime contract under a cash allowance. Prime contractor will, by the terms of the Contract Documents for the prime contract, be required to accept an assignment of, and assume complete responsibility for, the Contract.
- .4 As soon after award of the prime contract as Owner considers practicable, Owner will assign the Contract to the prime contractor.
- .5 The assignment will be made legally effective by means of an assignment agreement, to be signed by prime contractor, Contractor, and Owner.
- .6 Owner will give Contractor at least five (5) Working Days' notice in advance of the effective date of the assignment.
- .7 Upon assignment, all monies payable to Contractor as of the date of the assignment and other Owner's obligations under the Contract shall become obligations of prime contractor, subject to the terms of the assignment agreement.
- .8 Substantial Performance of the Work of the Contract, if not attained before the assignment, will be delayed so as to be attained concurrently with the date of Substantial Performance of the Work of the prime contract. Time of release of holdback for the Work of the Contract, commencement of warranty for the Work of the Contract, and other conditions of the Contract may therefore be affected and determined by the construction schedule for the prime contract, subject to the terms of the assignment agreement.

Waypoint Centre for Mental Healthcare
Toanche Building 3rd Floor Renovation Project
Penetanguishene, ON, Canada
CannonDesign Project No. 020708.51

December 18, 2023
ISSUED FOR TENDER

Part 2 Products – Not used.

Part 3 Execution – Not used.

END OF SECTION

Part 1 General

1.1 **RESTRICTIONS ON USE OF PREMISES**

- .1 Limit use of premises for Work, for storage, and for access, to allow:
 - .1 Owner occupancy.
 - .2 Partial Owner occupancy
 - .3 Work by other contractors.
 - .4 Public usage.
- .2 Coordinate use of premises under direction of Consultant.

1.2 **WORK SEQUENCE**

- .1 Schedule and construct Work in stages to accommodate Owner's use of premises during construction.
- .2 Required Stages: Phasing as per the Drawings.

1.3 **OWNER OCCUPANCY**

- .1 Owner will be completely vacated from 3rd Floor.
- .2 Cooperate with Owner in scheduling operations to minimize disruptions and to facilitate Owner usage of the remainder of facility.

1.4 **RESTRICTED HOURS OF WORK IN OCCUPIED FACILITIES**

- .1 Hours of work in accordance with Section 01 10 00 - Owner General Requirements.
- .2 Allow for hours of work restrictions in construction progress schedule.

1.5 **NOISY WORK RESTRICTIONS IN OCCUPIED FACILITIES**

- .1 Schedule excessively noisy work to avoid disturbance to building occupants. Perform excessive noise generating work outside of Owner's business hours.
- .2 Use powder actuated devices only with Consultant's written permission.

1.6 **MAINTAINING LIFE SAFETY SYSTEMS IN OCCUPIED FACILITIES**

- .1 Maintain operational life safety systems and public access to exits in occupied areas during stages of the Work.
- .2 Determine nature and exact locations of existing fire and smoke sensors prior to the commencement of the Work. Avoid direct or indirect jarring while working in adjacent areas and exercise caution to avoid triggering these devices.
- .3 Be responsible for costs incurred by Owner on account of false fire alarms activated because of the execution of the Work without adequate precautions.

Part 2 Products - Not used.

Part 3 Execution - Not used.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **CASH ALLOWANCES FOR SUPPLY ONLY OF PRODUCTS**

- .1 Amount of each cash allowance includes cost of Products as invoiced by the supplier, including delivery and applicable taxes but excluding Value Added Taxes.
- .2 Amount of each cash allowance does not include costs of the following items, which costs shall be included in the Contract Price and not in the cash allowance:
 - .1 Unloading, handling and storage on the Project site.
 - .2 Installation and other related costs.
 - .3 Overheads and profits related to the cash allowance.

1.2 **CASH ALLOWANCES FOR SUPPLY AND INSTALLATION OF PRODUCTS**

- .1 Amount of each cash allowance includes:
 - .1 Costs to provide the specified Products, including supply, installation, and related costs, excluding Value Added Taxes.
 - .2 Subcontractor's and sub-subcontractor's overheads and profits related to the cash allowance.
- .2 Amount of each cash allowance does not include Contractor's overhead and profit, and other related costs, which shall be included in the Contract Price and not in the cash allowance.
- .3 Allow the stipulated sum of \$250,000.00 for:
 - .1 Integration with existing building systems, including but not limited to, i.e., security code, white fire alarm, BAS.
 - .2 Hazardous materials.
 - .3 Premium time for afterhours work.

1.3 **CASH ALLOWANCES FOR SERVICES**

- .1 Amount of each cash allowance includes:
 - .1 Costs related to the services, excluding Value Added Taxes.
 - .2 Subcontractor's and sub-Subcontractor's overheads and profits related to the cash allowance.
- .2 Amount of each cash allowance does not include Contractor's overhead and profit, and other related costs, which shall be included in the Contract Price and not in the cash allowance.

1.4 **CASH ALLOWANCES FOR ASSIGNABLE CONTRACTS**

- .1 Owner has entered into assignable contracts, which will be assigned to this Contractor as specified in Section 01 11 20 - Contract Assignment.
- .2 Amount of each cash allowance includes the amount payable by Contractor to the designated Subcontractor after assignment of the assignable contract, excluding Value Added Taxes.

- .3 Amount of each allowance does not include the Contractor's overhead and profit, and other related costs, which costs shall be included in the Contract Price and not in the cash allowance.
- .4 Allow the stipulated sum for the assignment of:
 - .1 Hazardous materials at \$50,000 and premium time after hours work \$20,000.
 - .2 Cash Allowance \$50,000 include building integration.

1.1 **EXPENDITURE OF CASH ALLOWANCES**

- .1 Owner, through Consultant, will provide Contractor with documentation required to permit pricing of a cash allowance item.
- .2 Owner, through Consultant, may request Contractor to identify potential Suppliers or Subcontractors, as applicable, and to obtain at least three (3) competitive prices for each cash allowance item.
- .3 Owner, through Consultant, may request the Contractor to disclose originals of bids, quotations, and other price related information received from potential Suppliers or Subcontractors.
- .4 Owner, through Consultant, will determine by whom and for what amount each cash allowance item will be performed. Obtain Owner's prior written approval in the form of a Change Order before entering into a subcontract, amending an existing subcontract, or performing own forces work included in a cash allowance. Upon issuance of the Change Order, the Contractor's responsibilities for a cash allowance item shall be the same as for other Work of the Contract.

Part 2 Products - Not used.

Part 3 Execution - Not used.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Quantity measurement with unit value of *Products* determined by and expanded in the Bid Documents.
- .2 Schedule of products and their quantities.
- .3 Schedule of applicable values.

1.2 **SCHEDULE OF VALUES**

- .1 Submit a printed schedule of values on Canadian Construction Document Committee (CCDC) 24 electronic form using an authorized electronic signature.
- .2 Submit Schedule of Values within fifteen (15) days after date of *Owner-Contractor Agreement*.
- .3 Format: Utilize the Table of Contents of this *Project Manual*. Identify each line item with number and title of the primary associated specification section. Also identify [site mobilization] [bonds and insurance].
- .4 Include in each line item, the amount of Allowances specified in this Section. For unit cost Allowances, identify quantities taken from *Contract Documents* multiplied by the unit cost to achieve a total for the item.
- .5 Include within each line item, a direct proportional amount of *Contractor's* overhead and profit.
- .6 Revise schedule to list approved Change Orders, with each Application for Payment.

1.3 **SCHEDULE OF UNIT PRICE ITEMS**

- .1 Submit a separate price table of unit price items of Work using a CCDC 24 electronic form using an authorized electronic signature.
- .2 Make form of submittal parallel to Schedule of Values, with each line item identified same as line item in Schedule of Values. Include in unit prices only:
 - .1 Cost of material.
 - .2 Delivery and unloading at *Site*.
 - .3 Sales taxes.
 - .4 Installation, overhead and profit.
- .3 Ensure unit prices multiplied by quantities given equal material cost of that item in Schedule of Values.

1.4 **MEASUREMENT OF QUANTITIES**

- .1 Measurement Devices:
 - .1 Weigh Scales: Inspected, tested and certified by the applicable authority for weights and measures, within the past year.
 - .2 Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.
 - .3 Metering Devices: Inspected, tested and certified by the applicable authority within the past year.
- .2 Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes - measured by handbook weights. Welded assemblies measured by handbook or scale weight.
- .3 Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.

- .4 Measurement by Area: Measured by square dimension using mean length and width or radius.
- .5 Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.
- .6 Stipulated Sum/Price Measurement: Items measured by weight, volume, area, or linear means or combination as appropriate, as a completed item or unit of *Work*.

1.5 MEASUREMENT AND PAYMENT - UNIT PRICES

- .1 Authority for Specified Conditions: Measurement methods are delineated in the individual *Specification* sections. In the event of conflict, the requirements of the individual *Specification* section govern.
- .2 Authority for Changed Conditions: Measurement methods and unit prices are determined by the *Consultant*.
- .3 Take measurements and compute quantities. The *Consultant* will verify measurements and quantities.
- .4 The *Consultant* will take measurements and compute quantities accordingly. Provide and assist in the taking of measurements.
- .5 If the actual *Work* requires a 10% or greater change in quantity than those quantities indicated, the *Owner* or *Contractor* may claim for a *Contract Price* adjustment.
- .6 Unit Quantities: Quantities and measurements indicated in the Bid Form are for bid and contract purposes only. Quantities and measurements actually supplied or placed in the *Work* shall determine payment.
- .7 Payment Includes: Full compensation for required labour, Products, tools, equipment, plant and facilities, transportation, services and incidentals; erection, application or installation of an item of the *Work*; overhead and profit.

1.6 DEFECT ASSESSMENT

- .1 Replace the *Work*, or portions of the *Work*, not conforming to specified requirements.
- .2 If, in the opinion of the *Consultant*, it is not practical to remove and replace the *Work*, the *Consultant* will direct one (1) of the following two (2) remedies:
 - .1 The defective *Work* may remain, but the unit sum/price will be adjusted to a new sum/price at the discretion of the *Consultant*.
 - .2 The defective *Work* will be repaired to the instructions of the *Consultant*, the unit sum/price will be adjusted to a new sum/price at the discretion of the *Consultant*.
- .3 The individual *Specification* sections may modify these options or may identify a specific formula or percentage sum/price reduction.
- .4 The authority of the *Consultant* to assess the defect and identify payment adjustment is final.

1.7 NON-PAYMENT FOR REJECTED PRODUCTS

- .1 Payment will not be made for any of the following:
 - .1 *Products* wasted or disposed of in a manner that is not acceptable.
 - .2 *Products* determined as unacceptable before or after placement.
 - .3 *Products* not completely unloaded from the transporting vehicle.
 - .4 *Products* placed beyond the lines and levels of the required *Work*.
 - .5 *Products* remaining on hand after completion of the *Work*.
 - .6 Loading, hauling, and disposing of rejected *Products*.

1.8 **UNIT PRICE SCHEDULE**

.1 Unit Price Schedule:

.1 Unit Price No. 1 - Moisture Vapor Emission Control:

.1 Description: Moisture Vapor Emission Control according to Section 09 05 61 -
Moisture Vapour Emission Control.

.2 Unit of Measurement: Square foot.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SUMMARY**

- .1 Section includes administrative and procedural requirements for substitutions.

1.2 **DEFINITIONS**

- .1 In this Section "substitution" means a Product, a manufacturer or both, not originally specified in Contract Documents by proprietary name but proposed for use by Contractor in place of a Product, a manufacturer or both, specified by proprietary name.
- .2 Substitutions:
 - .1 Changes in products, materials, equipment and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - .2 Substitutions for Cause: Changes proposed by the Contractor that are required due to changed Project conditions, such as unavailability of Product, regulatory changes or unavailability of required warranty terms.
 - .3 Substitutions for Convenience: Changes proposed by the Contractor or the Owner that are not required in order to meet other Project requirements but may offer advantage to the Contractor or the Owner.

1.3 **SUBSTITUTION PROCEDURES**

- .1 Contractors may propose a substitution provided it meets the criteria outlined in Section 00 21 13 - Instructions to Bidders.
- .2 Contractor may propose a substitution wherever a Product or manufacturer is specified by proprietary name(s), unless there is accompanying language indicating that substitutions will not be considered.
- .3 Contractor may propose a substitution wherever a Product or manufacturer is specified by proprietary name(s) and accompanied by language such as "or approved alternate" or other similar words. Do not construe such language as an invitation to unilaterally provide a substitution without Consultant's prior acceptance in writing. Do not order or install substitution(s) without a Supplemental Instruction or Change Order.
- .4 Provided a proposed substitution submission includes the information specified herein, Consultant will promptly review and accept or reject the proposed substitution.
- .5 Consultant may accept a substitution if satisfied that:
 - .1 The proposed substitute Product is the same type as, is capable of performing the same functions as, interfaces with adjacent work the same as and meets or exceeds the standard of quality, performance and, if applicable, appearance and maintenance considerations, of the specified Product.
 - .2 The proposed substitute manufacturer has capabilities comparable to the specified manufacturer.
 - .3 The substitution provides a benefit to Owner.
- .6 If Contractor fails to order a specified Product or order a Product by a specified manufacturer in adequate time to meet Contractor's construction schedule, Consultant will not consider that a valid reason to accept a substitution.
- .7 If Consultant accepts a substitution and subject to Owner's agreement, the change in the Work will be documented in the form of either a Supplemental Instruction or Change Order as specified in Section 01 26 00 – Contract Modification Procedures.

- .8 If a substitution is accepted in the form of a Supplemental Instruction or Change Order, Contractor shall not revert to an originally specified Product or manufacturer without Consultant's prior written acceptance.

1.4 **SUBMISSION REQUIREMENTS FOR PROPOSED SUBSTITUTIONS**

- .1 Include with each proposed substitution the following information:
 - .1 Identification of the substitution, including product name and manufacturer's name, address, telephone numbers and web site.
 - .2 Reason(s) for proposing the substitution.
 - .3 A statement verifying that the substitution will not affect the Contract Price and Contract Time or, if applicable, the amount and extent of a proposed increase or decrease in Contract Price and Contract Time on account of the substitution.
 - .4 A statement verifying that the substitution will not affect the performance [or warranty] of other parts of the Work.
 - .5 Manufacturer's Product literature for the substitution, including material descriptions, compliance with applicable codes and reference standards, performance and test data, compatibility with contiguous materials and systems and environmental considerations.
 - .6 Product samples as applicable.
 - .7 A summarized comparison of the physical properties and performance characteristics of the specified Product and the substitution, with any significant variations clearly highlighted.
 - .8 Availability of maintenance services and sources of replacement materials and parts for the substitution, as applicable, including associated costs and time frames.
 - .9 If applicable, estimated life cycle cost savings resulting from the substitution.
 - .10 Details of other projects and applications where the substitution has been used.
 - .11 Identification of consequential changes in the Work to accommodate the substitution and consequential effects on the performance of the Work as a whole. A later claim for an increase to the Contract Price or Contract Time for other changes in the Work attributable to the substitution will not be considered.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Section includes administrative and procedural requirements for handling and processing *Contract* modifications.
- .2 Related Requirements: Section 01 25 00 - Substitution Procedures, for administrative procedures for handling requests for substitutions made after the *Contract* award.

1.2 **SCHEDULE OF LABOUR RATES**

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

1.3 **SCHEDULE OF EQUIPMENT RATES**

- .2 Equipment rates shall reflect the rates that will be used when:
 - .1 Preparing price quotations for Change Orders and
 - .2 Determining the cost of work attributable to Change Directives.
- .3 Equipment rates stated in the schedule shall be consistent with local equipment rental market rates and shall not include any additional overhead and profit component.
- .4 Obtain the Owner's written acceptance of the schedule of equipment rates before submitting the first Change Order quotation.
- .5 Accepted schedule of equipment rates will be used solely for evaluating Change Order quotations and cost of performing work attributable to Change Directives.

- .6 The Contractor may request amendments to the accepted schedule of equipment rates if changes in local equipment rental market rates can be demonstrated. Obtain the Owner's written acceptance of such changes.

1.4 **VALUATION OF CHANGES BASED ON AGREED UNIT PRICES**

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

1.5 **METHOD OF CONTRACT PRICE ADJUSTMENT - CHANGE ORDERS**

- .1 Unless otherwise agreed, the adjustment of the Contract Price on account of a proposed change in the Work shall be based on a quotation for a fixed price increase or decrease to the Contract Price regardless of the Contractor's actual expenditures and savings.
- .2 If necessary and unless otherwise agreed, the adjustment of the guaranteed maximum price (GMP) or the target contract price on account of a proposed change in the Work shall be based on a quotation for an increase or decrease to the GMP or target contract price. The increase or decrease shall include an adjustment to the Contractor's fixed fee, if any, as agreed by the Owner and the Contractor.

1.6 **CHANGE ORDER PROCEDURES**

- .1 Upon issuance by the Consultant to the Contractor of a proposed change in the Work and unless otherwise requested in the proposed change or unless otherwise agreed:
 - .1 Submit to the Consultant a fixed price quotation for the proposed change in the Work within five (5) Working Days after receipt of the proposed change in the Work.
 - .2 If requested in the proposed change, provide a detailed breakdown of the price quotation including the following to the extent applicable, with appropriate supporting documentation:
 - .1 Estimated labour costs, including hours and applicable hourly rates based on the accepted schedule of labour rates.
 - .2 Estimated Product costs, including Supplier quotations, estimated quantities and unit prices.
 - .3 Estimated Construction Equipment costs.
 - .4 Enumeration of other estimated costs included in the price quotation.
 - .5 Estimated credit amounts for labour and Products not required on account of the proposed change.
 - .6 Fees, not exceeding the applicable percentages for overhead and profit as specified herein.

- .7 Where applicable, Subcontractor quotations, also including a detailed breakdown of the above.
- .3 Include in the quotation the increase or decrease to the Contract Time, if any, for the proposed change, stated in number of days.
- .4 Include in the quotation the number of days for which the quotation is valid.
- .5 The quotation will be evaluated by the Consultant and the Owner and, if accepted by the Owner, be documented in the form of a signed Change Order.

1.7 FEES FOR OVERHEAD AND PROFIT – CHANGE ORDERS

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

1.8 METHOD OF CONTRACT PRICE ADJUSTMENT - CHANGE DIRECTIVES

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

1.9 CHANGE DIRECTIVE PROCEDURES

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

1.10 FEES FOR OVERHEAD AND PROFIT – CHANGE DIRECTIVES

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

1.11 SUPPLEMENTAL INSTRUCTIONS

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

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Applications for progress payments.
- .2 Substantial performance procedures.
- .3 Release of hold-back procedures.
- .4 Price adjustments.

1.2 **SCHEDULE OF VALUES**

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

1.3 **CASH FLOW PROJECTION**

- .1 Prior to the first application for payment submit, for Consultant's review, a forecast of approximate monthly progress payments for each month of the Contract Time.

- .2 Submit revised cash flow forecasts when requested by Consultant.

1.4 **WORKERS' COMPENSATION CLEARANCE**

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

1.5 **STATUTORY DECLARATIONS**

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

1.6 **PAYMENT FOR PRODUCTS STORED OFF SITE**

- .1 Owner may, due to extraordinary circumstances and at Owner's sole discretion, make payments for Products delivered to and stored at a location other than Place of the Work, subject to:
 - .1 a request submitted by Contractor in writing, with appropriate justification, and
 - .2 whatever conditions Owner or Consultant may establish for such payments, as required to protect Owner's interests.

1.7 **RELEASE OF HOLDBACK**

- .1 In accordance with the Act, forty-five (45) days after posting in DCN. No early release.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Pre-installation meetings.

1.2 **CONSTRUCTION START-UP MEETING**

- .1 Promptly after Contract award, Consultant will establish the time and location of a construction start-up meeting to review and discuss administrative procedures and responsibilities. Consultant will notify Contractor at least five (5) Working Days before the meeting.
- .2 Senior representatives of Owner, Consultant, sub-consultants, and Contractor, including Contractor's project manager and Project site superintendent, and major Subcontractors, shall be in attendance.
- .3 Consultant's representative will chair the meeting and record and distribute the minutes.
- .4 Agenda will include following:
 - .1 Appointment of official representatives of Owner, Contractor, Subcontractors, Consultant and sub-consultants.
 - .2 Project communications.
 - .3 Contract Documents for construction purposes.
 - .4 Documents at the Project site.
 - .5 Contractor's use of premises.
 - .6 Owner-supplied Products.
 - .7 Work restrictions.
 - .8 Cash allowances.
 - .9 Substitution procedures.
 - .10 Contract modification procedures.
 - .11 Payment procedures.
 - .12 Construction progress meetings.
 - .13 Construction progress schedule, including long lead time items.
 - .14 Submittals schedule and procedures.
 - .15 Quality requirements, including testing and inspection procedures.
 - .16 Contractor's mobilization.
 - .17 Temporary utilities.
 - .18 Existing utility services.
 - .19 Construction facilities.
 - .20 Temporary barriers and enclosures.
 - .21 Temporary controls.
 - .22 Field engineering and layout of work.
 - .23 Project site safety.

- .24 Project site security.
- .25 Cleaning and waste management.
- .26 Closeout procedures and submittals.
- .27 Commissioning.
- .28 Other items.

1.3 **CONSTRUCTION PROGRESS MEETINGS**

- .1 Schedule regular bi-weekly construction progress meetings for the duration of the Work. Contractor shall prepare meeting agendas, chair the meetings and record and distribute the minutes.
- .2 for the Owner will provide area for meetings.
- .3 Contractor shall record in the meeting minutes significant decisions and identify action items and action dates by attendees or the parties they represent.
- .4 Contractor shall distribute copies of minutes within three (3) Working Days after each meeting-to-meeting attendees and affected parties who may not be in attendance.
- .5 Ensure that Subcontractors attend as and when appropriate to the progress of the Work.
- .6 Agenda for each meeting shall include the following, as a minimum:
 - .1 Approval of minutes of previous meeting.
 - .2 Work progress since previous meeting.
 - .3 Field observations, including any problems, difficulties or concerns.
 - .4 Construction progress schedule.
 - .5 Submittals schedule.
 - .6 Proposed changes in the Work.
 - .7 Requests for information.
 - .8 Project site safety issues.
 - .9 Other business.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Contractor's responsibilities for preparation and submission of schedules and other documentation related to tracking construction progress.
- .2 The purpose of submitting progress schedules is to:
 - .1 Inform Owner and Consultant of actual progress versus planned progress, and
 - .2 Provide assurance that scheduling issues are being proactively identified and addressed in a timely manner, and that planned progress is being maintained as closely as possible.

1.2 **CONSTRUCTION PROGRESS SCHEDULE**

- .1 Format and Content:
 - .1 Prepare schedule in the form of a Critical Path Method (CPM) Gantt chart using appropriate scheduling software.
 - .2 Provide a work breakdown structure identifying key activities, work packages, and major milestones, including long delivery Products, inspection and testing activities, preparation and review of mock-ups, Owner decisions for cash allowances, shutdown or closure activities, demonstration and training activities and similar items, at a sufficient level of detail to effectively manage construction progress.
 - .3 Indicate milestone date[s] for Substantial Performance of the Work.
- .2 Submission:
 - .1 Submit initial schedule to Owner and Consultant within ten (10) Working Days after Contract award.
 - .2 Submit schedule via e-mail as .pdf files.
 - .3 Consultant will review format and content of initial schedule and request necessary changes, if any, within ten (10) Working Days after receipt.
 - .4 If changes are required, resubmit finalized initial schedule within five (5) Working Days after return of review copy.
 - .5 Submit updated progress schedule bi-weekly to Owner and Consultant, indicating actual and projected start and finish dates with report date line and progress, activity relationships, critical path, float, and baseline comparison to current progress.
 - .6 Include a written report with each updated progress schedule. Indicate work status to date comparing baseline to actual progress, current forecasts, identifying problem areas, anticipated delays and impact on schedule, and planned corrective actions.

1.3 **SUBMITTALS SCHEDULE**

- .1 Format and Content:
 - .1 Prepare schedule identifying required Shop Drawing, Product data, and sample submissions, including samples required for testing.
 - .2 Prepare schedule in electronic format.

- .3 Provide a separate line for each required submittal, organized by Specifications section names and numbers, and further broken down by individual Products and systems as required.
- .4 For each required submittal, show planned earliest date for initial submittal, earliest date for return of reviewed submittal by Consultant and latest date for return of reviewed submittal without causing delay.
- .5 Allow time in schedule for resubmission of submittals, should re-submission be necessary.
- .2 Submission:
 - .1 Submit initial schedule to Consultant within fifteen (15) Working Days after Contract award.
 - .2 Submit schedule via e-mail as .pdf files.
 - .3 Consultant will review format and content of initial schedule and request necessary changes, if any, within ten (10) Working Days after receipt.
 - .4 If changes are required, resubmit finalized schedule within five (5) Working Days after return of review copy.
 - .5 Submit updated submittals schedule monthly to Owner and Consultant..

1.4 **SCHEDULE MANAGEMENT**

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

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Shop Drawings and Product data.
- .2 Samples.

1.2 **ADMINISTRATIVE**

- .1 Submit specified submittals to Consultant for review. Submit with reasonable promptness and in orderly sequence to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time or for Product substitutions or other deviations from the Drawings and Specifications.
- .2 Where required by authorities having jurisdiction (AHJ), provide submittals to such authorities for review and approval.
- .3 Do not proceed with Work affected by a submittal until review is complete.
- .4 Present Shop Drawings, Product data and samples in imperial units. Where items or information is not produced in imperial units, converted values are acceptable.
- .5 Review submittals, provide verified field measurements where applicable and affix Contractor's review stamp prior to submission to Consultant. Contractor's review stamp represents that necessary requirements have been determined and verified and that the submittal has been checked and coordinated with requirements of the Work and Contract Documents.
- .6 Verify field measurements and that affected adjacent work is coordinated.
- .7 Submittals not meeting specified requirements will be returned with comments.
- .8 Reproduction of construction Drawings to serve as background for Shop Drawings is not permitted. If construction Drawings are used for this purpose, remove references to Consultant.
- .9 Do not propose substitutions or deviations from Contract Documents via Shop Drawing, Product data and sample submittals.

1.3 **SHOP DRAWINGS AND PRODUCT DATA**

- .1 Indicate Products, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of the Work.
- .2 Where Products attach or connect to other Products, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross-references to Drawings, Specifications and other already reviewed Shop Drawings.
- .3 Accompany submittals with a transmittal information including:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification of each submittal item and quantity.
 - .5 Other pertinent data.

- .4 Shop Drawing submittals shall include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, date and signature of Contractor's authorized representative responsible for Shop Drawing review, indicating that each Shop Drawing has been reviewed for compliance with Contract Documents and, where applicable, that field measurements have been verified.
 - .5 Details of appropriate portions of the Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationships to other parts of the Work.
- .5 Product data submittals shall include material safety data sheets (MSDS) for controlled Products.
- .6 Submit electronic copy of Shop Drawings where specified in the technical Specifications.
- .7 Submit electronic copy of Product data sheets or brochures where specified in the technical Specifications.
- .8 Where a submittal includes information not applicable to the Work, clearly identify applicable information and strike out non-applicable information.
- .9 Supplement standard information to include details applicable to Project.
- .10 Allow three (3) Working Days for Consultant's review of each submittal and incorporate in submittals schedule specified in Section 01 32 00 – Construction Progress Documentation.
- .11 If upon Consultant's review no errors or omissions are discovered or only minor corrections are required as indicated, submittal will be returned and fabrication or installation of Work may proceed.
- .12 If upon Consultant's review significant errors or omissions are discovered, a so noted copy will be returned for correction and re-submission. Do not commence fabrication or installation.

- .13 Consultant's notations on submittals are intended to ensure compliance with Contract Documents and are not intended to constitute a change in the Work requiring change to the Contract Price or Contract Time. If Contractor considers Consultant's notation to be a change in the Work, promptly notify Consultant in writing before proceeding with the Work.
- .14 Re-submit corrected submittals through same procedure indicated herein before fabrication or installation of the Work proceeds. When re-submitting, notify Consultant in writing of revisions other than those requested by Consultant.

1.4 **SAMPLES**

- .1 Submit samples for Consultant's review in triplicate where specified in technical Specifications. Label samples as to origin, Project name and intended use.
- .2 Deliver samples prepaid to Consultant's Project site office.
- .3 Notify Consultant in writing of deviations in samples from requirements of Contract Documents.
- .4 Where a required colour, pattern or texture has not been specified, submit full range of available Products meeting other specified requirements.
- .5 Consultant selection from samples is not intended to change the Contract Price or Contract Time. If a selection would affect the Contract Price or Contract Time, notify Consultant in writing prior to proceeding with the Work.
- .6 Resubmit samples as required by Consultant to comply with Contract Documents.
- .7 Reviewed and accepted samples will establish the standard against which installed Work will be reviewed.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Responsibilities for a single-source mental health specialist/coordinator.
- .2 Related Requirements: Refer to Section 01 88 53 - Behavioral Health Facilities Performance Requirements for general mental health performance requirements that apply to the post-construction performance of Work specified in other Specification Sections.

1.2 **QUALITY ASSURANCE**

- .1 Mental Health Specialist/Coordinator Qualifications:
 - .1 An experienced supplier or installer of mental health facility (or mental health facilities) Products and equipment who has completed mental health facility work installations similar in material, design and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.
 - .2 Experience:
 - .1 No fewer than two (2) completed mental health facility projects (or mental health facilities) that have been in operation for a minimum of two (2) years.
 - .2 Experienced in administration and supervision of mental health work, including mechanical and electrical mental health work and integration of its various components.
 - .3 Assignment: Employed by Contractor as a superintendent designated to perform the responsibilities of this Section in addition to other responsibilities within the Contractor's organization.
- .2 Qualification Data: For qualified Mental Health Facility Specialist/Coordinator to demonstrate capabilities and experience. Include the following:
 - .1 List of completed projects with project names and addresses; names, addresses and telephone numbers of architects, owners and contractors; and date of occupancy by Owner.

1.3 **MENTAL HEALTH SPECIALIST/COORDINATOR**

- .1 Responsibilities:
 - .1 Coordinate Work within patient access areas.
 - .2 Administrative procedures.
 - .3 Examination.
 - .4 Observe installation and startup checks of mental health work according to manufacturer's written instructions.
 - .5 Perform or facilitate demonstration and training for mental health hardware, equipment and furnishings.

1.4 MENTAL HEALTH WORK COORDINATION

- .1 Coordinate work within patient access areas to ensure efficient and orderly installation and proper operation of each part of mental health hardware, equipment and furnishings. Coordinate Work that depends on separate entities for proper installation, connection, patient safety and operation within patient access areas.
 - .1 Develop special procedures required for coordination of mental health Work.
 - .2 Coordinate installation of different mental health components and equipment, to ensure maximum accessibility for required maintenance, service and repair.
- .2 Coordinate installation of products furnished by Owner.
- .3 Review Shop Drawings and submittals of Products and equipment for patient safety provided by separate entities responsible for Work intended for patient access areas.
- .4 Secure time commitments for performing critical construction activities from separate entities responsible for installation of mental health hardware, equipment and furnishings.
 - .1 Schedule construction operations in sequence required to obtain best results where installation of one (1) part of mental health work depends on installation of other components, before or after its own installation.
- .5 Coordinate fastenings and anchorages for mental health work. Obtain and distribute to parties involved, setting drawings, templates and directions for installing anchorages, inserts, anchor bolts and items with integral anchors. Coordinate delivery of such items to Project site in time for installation.
 - .1 Check Shop Drawings of other Work to verify that adequate provisions are made for locating and installing mental health work to comply with indicated requirements.
- .6 Coordinate type of security fasteners for mental health work so no more than two (2) different sets of tools are required to operate security fasteners for entire Project. Coordinate submittal of extra fasteners and tools for maintenance material submittals.
- .7 Coordinate, schedule and approve interruptions of existing facilities and systems related to maintaining existing levels of security, including those necessary to make connections for temporary services.
 - .1 Provide information necessary to adjust, move or relocate existing mental health facilities and systems affected by mental health work.
 - .2 Locate connection points to existing mental health facilities and systems.
- .8 Coordinate preparation of Project Record Documents for mental health work and integrate information from entities responsible for mental health work to form one (1) combined record.
- .9 Coordinate preparation of operation and maintenance manuals for mental health work and integrate information from entities responsible for mental health work to form one (1) combined record.

Part 2 Products - Not Used.

Part 3 Execution - Not Used.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Safety requirements and adherence.

1.2 **REFERENCES**

- .1 Province of Ontario: Occupational Health and Safety Act, Regulation and Code R.S.A -Amended 1995, including requirements for a "Prime Contractor" as defined by the Act.

1.3 **SAFETY PLAN**

- .1 Develop written Site-specific Health and Safety Plan based on hazard assessment prior to commencing Site Work and continue to implement, maintain, and enforce plan until final demobilization from Site. Health and Safety Plan must address Specifications.
- .2 Consultant may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.4 **RESPONSIBILITY**

- .1 The "Prime Contractor" according to applicable local jurisdiction, is responsible for health and safety of persons on Site, safety of property on Site and for protection of persons adjacent to Site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations and ordinances and with Site specific Health and Safety Plan.
- .3 Should unforeseen or peculiar safety-related factor(s), hazard(s) or condition(s) become evident during performance of Work and follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of [Province] [Territory] having jurisdiction. Advise Consultant verbally and in writing.

1.5 **SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit Site specific Health and Safety Plan: Within seven (7) days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of Site-specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for Site tasks and operation [found in Work plan].
- .3 Submit three (3) copies of Contractor's authorized representative's Site health and safety inspection reports to the Consultant, weekly.
- .4 Submit copies of reports or directions issued by federal, provincial and territorial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit material safety data sheets (MSDS) to Consultant.

- .7 Consultant will review Contractor's Site-specific Health and Safety Plan and provide comments to Contractor within five (5) days after receipt of plan. Revise plan as appropriate and re-submit plan to Consultant within five (5) days after receipt of comments from Consultant.
- .8 Consultant's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: Where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for new Site personnel to Consultant.
- .10 On Site Contingency and Emergency Response Plan: Address standard operating procedures to be implemented during emergency situations.
- .11 File Notice of Project with Provincial authorities prior to commencement of Work.

1.6 SAFETY ACTIVITIES

- .1 Perform Site specific safety hazard assessment related to Project.
- .2 Schedule and administer Health and Safety meeting with Consultant prior to commencement of Work.
- .3 Perform Work in accordance with Section 01 40 00 - Quality Requirements and this section.

1.7 HEALTH AND SAFETY COORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Coordinator. Health and Safety Coordinator must:
 - .1 Have minimum two (2) years' Site-related working experience specific to activities associated with this type of construction, within this type of facility.
 - .2 Have working knowledge of occupational safety and health regulations.
 - .3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter Site to perform Work.
 - .4 Be responsible for implementing, enforcing daily and monitoring Site specific Contractor's Health and Safety Plan.
 - .5 Be on Site during execution of Work and report directly to and be under direction of Site supervisor.

1.8 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on the Project site in accordance with Acts and Regulations of Ontario having jurisdiction, and in consultation with Consultant.

1.9 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Consultant.

- .2 Provide Consultant with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Consultant may stop Work if non-compliance of health and safety regulations is not corrected.

1.10 **PROJECT/SITE CONDITIONS**

- .1 Work at Site will be on the completely open and vacant, 3rd floor.

1.11 **HAZARDOUS WORK**

- .1 Use powder actuated devices only after receipt of written permission from Consultant.

1.12 **WORK STOPPAGE**

- .1 Give precedence to safety and health of public and Site personnel and protection of environment over cost and schedule considerations for Work.

1.13 **FIRE PROTECTION**

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by [insurance companies having jurisdiction] governing codes, regulations and bylaws.
- .2 Burning rubbish and construction waste materials is not permitted on Site.
- .3 Maintain placed or installed fire resistive construction to protect the portions of the Work during construction.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Inspection and testing, administrative and enforcement requirements.
- .2 Inspection and testing agencies.
- .3 Inspection and testing agency reports.
- .4 Mock-ups.

1.2 **REFERENCE STANDARDS**

- .1 "Reference standards" means consensus standards, trade association standards, guides and other publications expressly referenced in Contract Documents.
- .2 Where an edition or version date is not specified, referenced standards shall be deemed to be the latest edition or revision issued by the publisher at the time of bid closing. However, if a particular edition or revision date of a specified standard is referenced in an applicable code or other regulatory requirement, the regulatory referenced edition or version shall apply.
- .3 Reference standards establish minimum requirements. If Contract Documents call for requirements that differ from a referenced standard, the more stringent requirements shall govern.
- .4 If compliance with two (2) or more reference standards is specified and the standards establish different or conflicting requirements, comply with the most stringent requirement. Refer uncertainties to Consultant for clarification.
- .5 Within the Specifications, reference may be made to the following standards writing, testing or certification organizations by their acronyms or initialisms:
 - .1 AA - Aluminum Association
 - .2 ACI - American Concrete Institute
 - .3 AISC - American Institute of Steel Construction
 - .4 ANSI - American National Standards Institute
 - .5 ASME - American Society of Mechanical Engineers
 - .6 ASTM - American Society for Testing and Materials
 - .7 AWMAC - Architectural Woodwork Manufacturers Association of Canada
 - .8 AWPA - American Wire Producers Association
 - .9 CaGBC - Canadian Green Building Council
 - .10 CGSB - Canadian General Standards Board
 - .11 CISC - Canadian Institute of Steel Construction
 - .12 CPCI - Canadian Prestressed Concrete Institute
 - .13 CSA - Canadian Standards Association
 - .14 CSSBI - Canadian Sheet Steel Building Institute
 - .15 CWB – Canadian Welding Bureau
 - .16 ICEA - Insulated Cable Engineers Association
 - .17 IEEE - Institute of Electrical and Electronics Engineers

- .18 IGMAC – Insulating Glass Manufacturers Association of Canada
- .19 LEED - Leadership in Energy and Environmental Design
- .20 MPP – Master Painters Institute
- .21 MSS - Manufacturers Standardization Society of the Valve and Fittings Industry
- .22 NAAMM - National Association of Architectural Metal Manufacturers
- .23 NEMA - National Electrical Manufacturers Association
- .24 NFPA - National Fire Protection Association
- .25 NHLA - National Hardwood Lumber Association
- .26 NLGA - National Lumber Grades Authority
- .27 SSPC – The Society for Protective Coatings
- .28 TTMAC - Terrazzo, Tile and Marble Association of Canada
- .29 ULC - Underwriters' Laboratories of Canada

1.3 **INDEPENDENT INSPECTION AND TESTING AGENCIES**

- .1 Except as otherwise specified, Owner will retain and pay for independent inspection and testing agencies to inspect, test or perform other quality control reviews of parts of the Work.
- .2 Retain and pay for inspection and testing that is for Contractor's own quality control or is required by regulatory requirements.
- .3 Section 01 21 00 – Allowances specifies a cash allowance for independent inspection and testing services to be retained and paid for by Contractor. Cash allowance excludes inspection and testing that is for Contractor's own quality control or is required by regulatory requirements.
- .4 Employment of inspection and testing agencies by Contractor or Owner does not relieve Contractor from responsibility to perform the Work in accordance with Contract Documents.
- .5 Allow and arrange for inspection and testing agencies to have access to the Work, including access to offsite manufacturing and fabrication plants.
- .6 For inspection and testing required by Contract Documents or by authorities having jurisdiction (AHJ), provide Consultant and inspection and testing agencies with timely notification in advance of required inspection and testing.
- .7 Submit test samples required for testing in accordance with submittals schedule specified in Section 01 32 00 – Construction Progress Documentation.
- .8 Provide labour, Construction Equipment and temporary facilities to obtain and handle test samples on site.

1.4 **INSPECTION AND TESTING AGENCY REPORTS**

- .1 For inspection and testing required by Contract Documents or by regulatory requirements and performed by Contractor retained inspection and testing agencies, submit to Consultant copies of reports. Submit within five (5) days after completion of inspection and testing.

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

1.5 **MOCK-UPS**

- .1 Prepare mock-ups of Work as specified in the technical Specifications. If a mock-up location is not indicated in the Drawings or Specifications, locate where directed by Consultant.
- .2 Modify mock-up as required until Consultant approval is obtained.
- .3 Approved mock-ups establish an acceptable standard for the Work.
- .4 Protect mock-ups from damage until the Work they represent is complete.
- .5 Unless otherwise specified in the technical Specifications, approved mock-ups forming part of the Work may remain as part of the Work.
- .6 Remove mock-ups only when the Work they represent is complete or when otherwise directed by Consultant.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Temporary utilities.

1.2 **TEMPORARY WATER SUPPLY**

- .1 Connect to and use Owner's existing water supply for temporary use during construction, subject to existing available volume and pressure. Usage at no cost to Contractor, but Contractor to provide labour to connect.
- .2 Arrange and pay for necessary water supply connections and disconnections.

1.3 **TEMPORARY HEATING AND VENTILATION**

- .1 Connect to, and use existing heating and ventilation required during construction.
- .2 Vent construction heaters in enclosed spaces to the outside or use flameless type of construction heaters.
- .3 Provide temporary heat for the Work as required to:
 - .1 Facilitate progress of Work.
 - .2 Protect the Work against dampness and cold.
 - .3 Prevent moisture condensation on surfaces, freezing, or other damage to finishes or stored Products.
 - .4 Maintain specified minimum ambient temperatures and humidity levels for storage, installation and curing of Products.
 - .5 After building is enclosed, maintain interior temperature of minimum 10°C.
- .4 Provide temporary ventilation for the Work as required to:
 - .1 Prevent accumulations of fumes, exhaust, vapours, gases and other hazardous, noxious, or volatile substances in enclosed spaces, as required to maintain a safe work environment meeting applicable regulatory requirements.
 - .2 Ensure that hazardous, noxious, or volatile substances do not migrate to Owner occupied spaces.
 - .3 Ventilate temporary sanitary facilities.

1.4 **TEMPORARY ELECTRICAL POWER AND LIGHTING**

- .1 Connect to and use Owner's existing electrical supply for temporary use during construction. Usage at no cost to Contractor, but Contractor to provide labour to connect.
- .2 Existing maximum power supply is available for temporary use during construction. Contractor to confirm at the Project site.
- .3 Arrange and pay for necessary connections and disconnections of temporary power and lighting in accordance with regulatory requirements.

1.5 **EXISTING BUILDING HEATING, VENTILATION, POWER AND LIGHTING**

- .1 Existing building heating, ventilation, power, and lighting may be relied upon and used during construction except during hours or days when the building is not operational.

- .2 Establish expectations regarding infection control and negative pressure. Existing ductwork must not be used for these purposes.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Parking.
- .2 Vehicular access.
- .3 Project site offices.
- .4 Sanitary facilities.
- .5 Fire Protection.
- .6 Construction aids.
- .7 Project identification.

1.2 **CONSTRUCTION FACILITIES - GENERAL**

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

1.3 **CONSTRUCTION PARKING**

- .1 Limited parking will be permitted at Place of the Work at locations indicated provided.
- .2 Contractors will require a valid Waypoint parking pass to be able to park on the site.

1.4 **VEHICULAR ACCESS**

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

1.5 **PROJECT SITE OFFICES**

- .1 Provide a temperature controlled and ventilated office, with suitable lighting, of sufficient size to accommodate Project site meetings and furnished with drawing laydown table.
- .2 Consultant's Project site office:
 - .1 Temporary office space for Consultant within 3rd floor work area.
 - .2 Provide at least one (1) operable window and a lockable door.
 - .3 Provide office with temperature control, ventilation and suitable power and lighting.
 - .4 Washroom facilities available for use on the 3rd floor work area.

1.6 **SANITARY FACILITIES**

- .1 Workers shall make use of existing washrooms within the work area.
- .2 When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures, inside public areas of the building.
- .3 Do not use permanent washroom facilities during construction.

- .4 Keep sanitary facilities clean and fully stocked with the necessary supplies.

1.7 FIRE PROTECTION

- .1 Provide and maintain temporary fire protection systems and equipment during construction.

1.8 ELEVATORS

- .1 Permanent elevators may be used by construction personnel and for transporting Products, at Contractor's option. If used during construction:
 - .1 Provide protective coverings for finish surfaces of cars and entrances.
 - .2 Just prior to Substantial Performance of the Work, perform required maintenance to ensure elevators are in as near as new condition as possible.
 - .3 Ensure that elevator manufacturer's warranty does not commence until the date of Substantial Performance of the Work or, if manufacturer's warranty does commence earlier when elevators are put into use, arrange for necessary extension of manufacturer's warranty or provide equivalent coverage under Contractor's warranty.

1.9 USE OF EXISTING ELEVATORS

- .1 Designated elevators may be used by construction personnel and for transporting Products. Coordinate use with Jim Middaugh of Waypoint Centre for Mental Healthcare.
- .2 Provide protective coverings for finish surfaces of cars and entrances. Assume responsibility for and make good any damage to existing elevators caused by construction personnel.

1.10 PROJECT IDENTIFICATION SIGNS

- .1 Provide one (1) Project identification sign. Graphics and text shall indicate name of Project, name and logo of Owner and Contractor.
- .2 Project identification sign(s) shall be minimum 1200 x 2400 mm, of wood frame and plywood construction with graphics produced by a professional sign company.
- .3 Submit Shop Drawing for Project identification sign graphics and text.
- .4 Erect sign(s) within three (3) weeks upon mobilization to the Project site, but no more than four (4) weeks from Contract award in location(s) directed or approved by Consultant.
- .5 No other signs or advertisements, other than safety, warning or directional signs, are permitted without Consultant's prior approval.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Barriers and enclosures – general.
- .2 Fencing.
- .3 Exterior hoarding.
- .4 Weather enclosures.
- .5 Dust tight screens and/or partitions.
- .6 Fire routes.
- .7 Protection of building finishes.

1.2 **BARRIERS AND ENCLOSURES - GENERAL**

- .1 Provide temporary barriers and enclosures necessary to protect the public and building occupants and to secure Place of the Work during performance of the Work.
- .2 Comply with applicable regulatory requirements.
- .3 Maintain temporary barriers and enclosures in good condition for the duration of the Work.
- .4 Remove temporary barriers and enclosures from Place of the Work when no longer required.

1.3 **FENCING**

- .1 Erect temporary security and safety Project site fencing of type and height determined by Contractor, subject to applicable regulatory requirements, for the purpose of protecting and storing products and materials used for this Project.
- .2 Provide lockable access gates as required to facilitate construction access.

1.4 **WEATHER ENCLOSURES**

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

1.5 **DUST TIGHT PARTITIONS**

- .1 Provide dust and airtight, weather-stripped partitions to localize interior building areas from dust and noise generating activities.
- .2 Erect, maintain, and relocate partitions as required to facilitate construction operations and Owner's operational requirements.
- .3 Dust tight partitions to be constructed to the Owners standards. Partitions to be inspected and approved by the Owner's IPAC coordinator.

1.6 **FIRE ROUTES**

- .1 Maintain fire access routes, including overhead clearances, for use by emergency response vehicles.

1.7 **PROTECTION OF BUILDING FINISHES**

- .1 Provide necessary temporary barriers and enclosures to protect existing and completed or partially completed finished surfaces from damage during performance of the Work.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Temporary controls as necessary for performance of the Work and in compliance with applicable regulatory requirements.
- .2 Maintenance of temporary controls in good condition for the duration of the Work.
- .3 Removal of controls and Construction Equipment used to provide temporary controls from Place of the Work when no longer required.

1.2 **DUST AND PARTICULATE CONTROL**

- .1 Implement and maintain dust and particulate control measures in accordance with applicable regulatory requirements.
- .2 Execute Work by methods that minimize dust from construction operations and spreading of dust on the Project site or to adjacent properties.
- .3 Provide temporary enclosures to prevent extraneous materials resulting from sandblasting or similar operations from contaminating air beyond immediate work area.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.
- .5 Use appropriate covers on trucks hauling fine, dusty or loose materials.

1.3 **POLLUTION CONTROL**

- .1 Take measures to prevent contamination of water and atmosphere through uncontrolled discharge of noxious or toxic substances and other pollutants, potentially causing environmental damage.
- .2 Be prepared, by maintaining appropriate materials, equipment and trained personnel on the Project site, to intercept, clean up and dispose of spills or releases that may occur. Promptly report spills and releases that may occur to:
 - .1 Authority having jurisdiction (AHJ).
 - .2 Person causing or having control of pollution source, if known.
 - .3 Owner and Consultant.
- .4 Contact manufacturer of pollutant, if known and applicable, to obtain material safety data sheets (MSDS) and ascertain hazards involved and precautions and measures required in cleanup or mitigating actions.
- .5 Take immediate action to contain and mitigate harmful effects of the spill or release.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Product options.
- .2 Product availability and delivery times.
- .3 Product storage, handling and protection.

1.2 **GENERAL**

- .1 Provide Products that are not damaged or defective and suitable for purpose intended, subject to specified requirements. If requested by Consultant, furnish evidence as to type, source and quality of Products provided.
- .2 Unless otherwise specified, maintain uniformity of manufacture for like items throughout.
- .3 Permanent manufacturer's markings, labels, trademarks and nameplates on Products not acceptable in prominent locations, except where required by regulatory requirements or for operating instructions or when located in mechanical or electrical rooms.

1.3 **PRODUCT OPTIONS**

- .1 Subject to the provisions of Section 01 25 00 –Substitution Procedures:
 - .1 Wherever a Product or manufacturer is specified by a single proprietary name, provide the named Product only.
 - .2 Wherever more than one (1) Product or manufacturer is specified by proprietary name for a single application, provide any, one (1) of the named Products.
- .2 Wherever a Product is specified by reference to a standard only, provide Product that meets or exceeds specified standard. If requested by Consultant, submit information verifying that the proposed Product meets or exceeds the specified standard.
- .3 Wherever a Product is specified by descriptive or performance requirements only, provide Product that meets or exceeds the specified requirements. If requested by Consultant, submit information verifying that the proposed Product meets or exceeds the specified requirements.

1.4 **PRODUCT AVAILABILITY AND DELIVERY TIMES**

- .1 Promptly upon Contract award and periodically during construction, review and confirm Product availability and delivery times. Order Products in sufficient time to meet the construction progress schedule and the Contract Time.
- .2 If a specified Product is no longer available, promptly notify Consultant. Consultant will take action as required.
- .3 If delivery delays are foreseeable, for any reason, promptly notify Consultant.
 - .1 If delivery delay is beyond Contractor's control, Consultant to provide direction.
 - .2 If a delivery delay is caused by something that was or is within Contractor's control, Contractor shall propose actions to maintain the construction progress schedule for Consultant's review and acceptance.

1.5 STORAGE, HANDLING AND PROTECTION

- .1 Store, handle and protect Products during transportation to Place of the Work and before, during and after installation in a manner to prevent damage, adulteration, deterioration and soiling.
- .2 Comply with manufacturer's instructions for storage, handling and protection.
- .3 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact. Do not remove from packaging or bundling until required in Work.
- .4 Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials, including requirements for labeling and the provision of material safety data sheets (MSDS).
- .5 Store Products subject to damage from weather in weatherproof enclosures.
- .6 Store sheet Products on flat, solid, supports and keep clear of ground. Slope to shed moisture.
- .7 Remove and replace damaged Products.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Survey services to determine measurement inverts for the Work.
- .2 Requirements and limitations for cutting and patching the Work.

1.2 **SUBMITTALS**

- .1 Submit name and address of registered land surveyor performing survey work.

1.3 **EXISTING UTILITIES AND STRUCTURES**

- .1 Promptly notify Consultant if utilities, structures or their locations differ from those indicated in Contract Documents or in available Project information. Consultant will provide appropriate direction.
- .2 Record locations of maintained re-routed and abandoned utility lines.

1.4 **VERIFICATION OF EXISTING CONDITIONS**

- .1 Where work specified in any Section is dependent on the Work of another Section(s) having been properly completed, verify that Work is complete and, in a condition, suitable to receive the subsequent work. Commencement of Work of a Section that is dependent on the Work of another Section or Sections having been properly completed, means acceptance of the existing conditions.
- .2 Verify that ambient conditions are suitable before commencing the Work of any Section and will remain suitable for as long as required for proper setting, curing or drying of Products used.
- .3 Ensure that substrate surfaces are clean, dimensionally stable, cured and free of contaminants.
- .4 Notify Consultant in writing of unacceptable conditions.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Except where otherwise specified in technical Specifications or otherwise indicated on Drawings, comply with requirements of this Section.

1.2 **MANUFACTURER'S INSTRUCTIONS**

- .1 Install, erect or apply Products in strict accordance with manufacturer's instructions.
- .2 Notify Consultant, in writing, of conflicts between Contract Documents and manufacturer's instructions where, in Contractor's opinion, conformance with Contract Documents instead of the manufacturer's instructions may be detrimental to the Work or may jeopardize the manufacturer's warranty.
- .3 Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
- .4 Provide manufacturer's representatives with access to the Work at all times. Render assistance and facilities for such access so that manufacturer's representatives may properly perform their responsibilities.

1.3 **CONCEALMENT**

- .1 Conceal pipes, ducts and wiring in floors, walls and ceilings in finished areas:
 - .1 after review by Consultant and authority having jurisdiction and
 - .2 where locations differ from those shown on Drawings, after recording actual locations on as-built drawings.
- .2 Provide incidental furring or other enclosures as required.
- .3 Notify Consultant in writing of interferences before installation.

1.4 **FASTENINGS - GENERAL**

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials.
- .2 Prevent electrolytic action and corrosion between dissimilar metals and materials by using suitable non-metallic strips, washers, sleeves or other permanent separators to avoid direct contact.
- .3 Use non-corrosive fasteners and anchors for securing exterior work and in spaces where high humidity levels are anticipated.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Do not use fastenings or fastening methods that may cause spalling or cracking of material to which anchorage is made.

1.5 **FASTENINGS - EQUIPMENT**

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .2 Bolts shall not project more than one diameter beyond nuts.

1.6 FIRE RATED ASSEMBLIES

- .1 When penetrating fire rated walls, ceiling or floor assemblies, completely seal voids with fire-stopping materials, smoke seals or both, in full thickness of the construction element as required to maintain the integrity of the fire rated assembly.

1.7 LOCATION OF FIXTURES, OUTLETS AND DEVICES

- .1 Consider location of fixtures, outlets and devices indicated on Drawings as approximate.
- .2 Locate fixtures, outlets and devices to provide minimum interference, maximum usable space and as required to meet safety, access, maintenance, acoustic and regulatory, including barrier free, requirements.
- .3 Promptly notify Consultant in writing of conflicting installation requirements for fixtures, outlets and devices. If requested, indicate proposed locations and obtain approval for actual locations.

1.8 PROTECTION OF COMPLETED WORK AND WORK IN PROGRESS

- .1 Adequately protect parts of the Work completed and in progress from any kind of damage.
- .2 Promptly remove, replace, clean or repair, as directed by Consultant, work damaged as a result of inadequate protection.
- .3 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the safety or integrity of the Work.

1.9 REMEDIAL WORK

- .1 Notify Consultant of and perform remedial work required to, repair or replace defective or unacceptable work. Ensure that properly qualified workers perform remedial work. Coordinate adjacent affected work as required.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

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

1.2 **REQUEST FOR CUTTING, PATCHING AND REMEDIAL WORK**

- .1 Submit written request in advance of cutting, coring or alteration which affects or is likely to affect:
 - .1 Structural integrity of any element of the Work.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance or safety of any operational element.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or other contractors.
 - .6 Warranty of Products affected.
- .2 Include in request:
 - .1 Identification of Project.
 - .2 Location and description of affected work, including drawings or sketches as required.
 - .3 Statement on necessity for cutting or alteration.
 - .4 Description of proposed Work and Products to be used.
 - .5 Alternatives to cutting and patching.
 - .6 Effect on work of Owner or other contractors.
 - .7 Written permission of affected other contractors.
 - .8 Date and time work will be executed.

1.3 **PRODUCTS**

- .1 Unless otherwise specified, when replacing existing or previously installed Products while cutting and patching work, use replacement Products of the same character and quality as those being replaced.
- .2 If an existing or previously installed Product must be replaced with a different Product, submit request for substitution in accordance with Section 01 25 00 - Substitution Procedures.

1.4 **PREPARATION**

- .1 Inspect existing conditions in accordance with Section 01 71 00 - Examination and Preparation.
- .2 Provide supports to ensure structural integrity of surroundings; provide devices and methods to protect other portions of the Work from damage.
- .3 Provide protection from elements for areas that may be exposed by uncovering work.

1.5 EXISTING UTILITIES

- .1 Where the Work involves breaking into or connecting to existing services, give authority having jurisdiction (AHJ), Owner and Consultant, forty-eight (48) hours notice for necessary interruption of mechanical or electrical services.
- .2 Maintain excavations free of water.
- .3 Keep duration of interruptions to a minimum.
- .4 Carry out interruptions after regular working hours of occupants, preferably on weekends, unless Owner's prior written approval is obtained.
- .5 Protect and maintain existing active services. Record location of services, including depth, on as-built Drawings.
- .6 Construct or erect barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures as required to protect pedestrian and vehicular traffic.

1.6 CUTTING, PATCHING AND REMEDIAL WORK

- .1 Coordinate and perform the Work to ensure that cutting and patching work is kept to a minimum.
- .2 Perform cutting, fitting, patching and remedial work to make the affected parts of the Work come together properly and complete the Work.
- .3 Provide openings in non-structural elements of the Work for penetrations of mechanical and electrical work.
- .4 Perform cutting by methods to avoid damage to other work
- .5 Provide proper surfaces to receive patching, remedial work and finishing.
- .6 Perform cutting, patching and remedial work using competent and qualified specialists familiar with the Products affected, in a manner that neither damages nor endanger the Work.
- .7 Do not use pneumatic or impact tools without Consultant's prior approval.
- .8 Ensure that cutting, patching and remedial work does not jeopardize manufacturers' warranties.
- .9 Refinish surfaces to match adjacent finishes. For continuous surfaces refinish to nearest intersection. For an assembly, refinish entire unit.
- .10 Fit work to pipes, sleeves, ducts, conduit and other penetrations through surfaces with suitable allowance for deflection, expansion, contraction, acoustic isolation and firestopping.
- .11 Maintain fire ratings of fire rated assemblies where cutting, patching or remedial work is performed. Completely seal voids or penetrations of assembly with firestopping material to full depth or with suitably rated devices.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Cleaning and waste management.

1.2 **REGULATORY REQUIREMENTS**

- .1 Comply with applicable regulatory requirements when disposing of waste materials.
- .2 Obtain permits from authorities having jurisdiction (AHJ) and pay disposal fees where required for disposal of waste materials and recyclables.

1.3 **GENERAL CLEANING REQUIREMENTS**

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

1.4 **PROGRESSIVE CLEANING AND WASTE MANAGEMENT**

- .1 Maintain the Work in a tidy and safe condition, free from accumulation of waste materials and construction debris.
- .2 Provide appropriate, clearly marked, containers for collection of waste materials and recyclables.
- .3 Remove waste materials and recyclables from work areas, separate and deposit in designated containers at end of each Working Day. Collect packaging materials for recycling or reuse.
- .4 Remove waste materials and recyclables from Place of the Work daily.
- .5 Clean interior building areas prior to start of finish work and maintain free of dust and other contaminants during finishing operations.
- .6 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly finished surfaces nor contaminate building systems.

1.5 **FINAL CLEANING**

- .1 Before final cleaning, arrange a meeting at Place of the Work to determine the acceptable standard of cleaning. Ensure that Owner, Contractor and cleaning company are in attendance.
- .2 Remove from Place of the Work surplus Products, waste materials, recyclables, Temporary Work and Construction Equipment not required to perform any remaining work.
- .3 Provide professional cleaning by a qualified, established cleaning company.
- .4 Lock or otherwise restrict access to each room or area after completing final cleaning in that area.
- .5 Re-clean as necessary areas that have been accessed by Contractor's workers prior to Owner occupancy.

- .6 Remove stains, spots, marks and dirt from finished surfaces, electrical and mechanical fixtures, furniture fitments, walls and floors.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and other finished surfaces, including mechanical and electrical fixtures. Replace broken, scratched or otherwise damaged glass.
- .8 Remove dust from lighting reflectors, lenses, lamps, bulbs and other lighting surfaces.
- .9 Vacuum clean and dust exposed wall, floor and ceiling surfaces, behind grilles, louvres and screens and above suspended ceiling tiles.
- .10 Clean mechanical, electrical and other equipment. Replace filters for mechanical equipment if equipment is used during construction.
- .11 Remove waste material and debris from crawlspaces and other accessible concealed spaces.
- .12 Remove stains, spots, marks and dirt from exterior facades.
- .13 Clean exterior and interior window glass and frames.
- .14 Use leaf blowers to clean landscaped surfaces.

1.6 **WASTE MANAGEMENT AND DISPOSAL**

- .1 Dispose of waste materials and recyclables at appropriate municipal landfills and recycling facilities in accordance with applicable regulatory requirements.
- .2 Do not burn or bury waste materials at Place of the Work.
- .3 Do not dispose of volatile and other liquid waste such as mineral spirits, oil, paints and other coating materials, paint thinners, cleaners and similar materials together with dry waste materials or on the ground, in waterways or in storm or sanitary sewers. Collect such waste materials in appropriate covered containers, promptly remove from Place of the Work and dispose of at recycling facilities or as otherwise permitted by applicable regulatory requirements.
- .4 Cover or wet down dry waste materials to prevent blowing dust and debris.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Section includes administrative and procedural requirements for Contract closeout.

1.2 **READY-FOR-TAKEOVER**

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

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

- .1 Contractor's Inspection: Before applying for the Consultant's review to establish Ready-for-Takeover of the Work:
 - .1 Ensure that the specified prerequisites to Ready-for-Takeover of the Work are completed.
 - .2 Conduct an inspection of the Work to identify defective, deficient or incomplete work.
 - .3 Prepare a comprehensive and detailed list of items to be completed or corrected.
 - .4 Provide an anticipated schedule and costs for items to be completed or corrected.
- .2 Consultant's Review: Upon receipt of the Contractor's application for review, together with the Contractor's list of items to be completed or corrected, the Consultant will review the Work. The Consultant will advise the Contractor whether the Work is Ready-for-Takeover and will provide the Contractor with a list of items, if any, to be added to the Contractor's list of items to be completed or corrected. Provide the Consultant with a copy of the Contractor's revised list.
- .3 Maintain the list of items to be completed or corrected and promptly correct or complete defective, deficient and incomplete work. The Contractor's inspection and Consultant's review procedures specified above shall be repeated until the Work is Ready-for-Takeover and no items remain on the Contractor's list of items to be completed or corrected.
- .4 When the Consultant determines that the Work is Ready-for-Takeover, the Consultant will notify the Contractor and the Owner in writing to that effect.

1.4 **PREREQUISITES TO FINAL PAYMENT**

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

1.5 PARTIAL USER OCCUPANCY

- .1 If partial Owner occupancy of a part of the Work is required before the date of Ready-for-Takeover of the entire Work of the Contract, the provisions of this Section shall apply, to the extent applicable to that part of the Work that the Owner intends to occupy.

1.6 SUBSTANTIAL PERFORMANCE OF THE WORK

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

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Closeout submittals.
- .2 Operation and maintenance manual.
- .3 Operation and maintenance manual format.
- .4 Operation and maintenance manual – general content.
- .5 Operation and maintenance manual – equipment and systems content.
- .6 Operation and maintenance manual – products and finishes content.
- .7 Operation and maintenance manual – warranties content.
- .8 Contractors as-built drawings.
- .9 Project record documents.
- .10 Spare parts, maintenance materials and special tools.
- .11 Building information model (BIM) and computer aided facility management (CAFM).

1.2 **OPERATION AND MAINTENANCE MANUAL**

- .1 Prepare a comprehensive operation and maintenance manual, in the language[s] of the Contract, using personnel qualified and experienced for this task.
- .2 Submit an initial draft of the operation and maintenance manual for Consultant's review. If required by Consultant's review comments, revise manual contents and re-submit for Consultant's review. If required, repeat this process until Consultant accepts the draft manual in writing.
- .3 Submit final version to Owner in hard copy and electronic format.

1.3 **OPERATION AND MAINTENANCE MANUAL FORMAT**

- .1 Organize data in the form of an instructional manual.
- .2 Binders: vinyl, hard covered, three (3) D-rings, loose leaf, 8 ½" x 11" (216 x 279 mm), with spine and face pockets.
- .3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: Identify each binder with typed or printed title "Operation and Maintenance Manual", name of Project or facility and subject matter of contents.
- .5 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate Product or system, with typed description of Product and major component parts of equipment.
- .7 Text: Manufacturer's printed data or typewritten data.
- .8 Drawings: Provide with reinforced punched binder tab. Bind in with text, fold larger drawings to size of text pages.
- .9 Provide electronic copy of manual in PDF format.
- .10 Provide electronic copy of Shop Drawings in manual as 1:1 scaled CAD files in.dwg format on electronic media acceptable to Owner.

1.4 OPERATION AND MAINTENANCE MANUAL – GENERAL CONTENT

- .1 Table of contents for each volume.
- .2 Introductory information including:
 - .1 Date of manual submission.
 - .2 Complete contact information for Consultant, sub-consultants, other consultants and Contractor, with names of responsible parties.
 - .3 Schedule of Products and systems indexed to content of volume.
- .3 For each Product or system, include complete contact information for Subcontractors, Suppliers and manufacturers, including local sources for supplies and replacement parts.
- .4 Product Data: Mark each sheet to clearly identify specific Products, options and component parts and data applicable to installation. Delete or strike out inapplicable information. Supplement with additional information as required.
- .5 Reviewed Shop Drawings.
- .6 Permits, certificates, letters of assurance and other relevant documents issued by or required by authorities having jurisdiction (AHJ).
- .7 Warranties.
- .8 Operating and maintenance procedures, incorporating manufacturer's operating and maintenance instructions, in a logical sequence.
- .9 Training materials as specified in Section 01 79 00 - Demonstration and Training.

1.5 OPERATION AND MAINTENANCE MANUAL - EQUIPMENT AND SYSTEMS CONTENT

- .1 Each Item of Equipment and Each System: Include description of unit or system and component parts. Give function, normal operation characteristics and limiting conditions. Include performance curves, with engineering data and tests and complete nomenclature and commercial number of replaceable parts.
- .2 Panel Board Circuit Directories: Provide electrical service characteristics, controls and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: Include start-up, break-in and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down and emergency instructions. Include summer, winter and special operating instructions.
- .5 Maintenance Requirements: Include routine procedures and guide for trouble-shooting; disassembly, repair and reassembly instructions and alignment, adjusting, balancing and checking instructions.
- .6 Provide servicing and lubrication schedule and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.

- .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
 - .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
 - .13 Provide list of original manufacturer's spare parts, current prices and recommended quantities to be maintained in storage.
 - .14 Include testing and balancing reports.
 - .15 Include additional content as specified in technical Specifications sections.
- 1.6 **OPERATION AND MAINTENANCE MANUAL - PRODUCTS AND FINISHES CONTENT**
- .1 Include Product data, with catalogue number, options selected, size, composition and colour and texture designations. Provide information for re-ordering custom manufactured Products.
 - .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
 - .3 Include an outline of requirements for routine and special inspections and for regular maintenance to ensure that on-going performance of the building envelope will meet the initial building envelope criteria.
 - .4 Include additional content as specified in technical Specifications sections.
- 1.7 **OPERATION AND MAINTENANCE MANUAL - WARRANTIES CONTENT**
- .1 Separate each warranty with index tab sheets keyed to Table of Contents listing.
 - .2 List each warrantor with complete contact information.
 - .3 Verify that documents are in proper form and contain full information. Ensure that warranties are for the correct duration and are in Owner's name.
 - .4 Include maintenance bond(s).
- 1.8 **CONTRACTOR'S AS-BUILT DRAWINGS**
- .1 Submit final as-built drawings in the form specified in Section 01 32 00 – Construction Progress Documentation to Consultant.
- 1.9 **PROJECT RECORD DRAWINGS**
- .1 Transfer information marked up on as-built drawings during the progress of the Work to a master set of record drawing files provided by Consultant, in electronic format.
 - .2 Mark revised Drawings as "RECORD DRAWINGS".
 - .3 Submit completed record drawings in electronic form to Owner and Consultant.
- 1.10 **SPARE PARTS, MAINTENANCE MATERIALS AND SPECIAL TOOLS**
- .1 Supply spare parts, maintenance materials and special tools in quantities specified in technical Specifications Sections.
 - .2 Ensure spare parts and maintenance materials are new, not damaged nor defective and of same quality, manufacturer and batch or production run as installed Products.

- .3 Provide tags for special tools identifying their function and associated Product.
- .4 Deliver to and store items at location directed by Owner at Place of the Work. Store in original packaging with manufacturer's labels intact and in a manner to prevent damage or deterioration.
- .5 Catalogue items and submit to Consultant an inventory listing organized by Specifications Section. Include Consultant reviewed inventory listing in operation and maintenance manual.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Procedures for demonstration and instruction of Products, equipment and systems to Owner's Demonstrate and provide training to Owner's personnel on operation and maintenance of equipment and systems prior to scheduled date of Substantial Performance of the Work.

1.2 **SUBMITTALS**

- .1 Submit proposed dates, times, durations and locations for demonstration and training of each item of equipment and each system for which demonstration and training is required. Allow sufficient time for training and demonstration for each item of equipment or system or time as may be specified in technical Specifications.
- .2 Consultant and Owner will review submittal and advise Contractor of necessary revisions.
- .3 Submit report(s) within five (5) Working Days after completion of demonstration and training:
 - .1 Identifying time and date of each demonstration and training session.
 - .2 Summarizing the demonstration and training performed.
 - .3 Including a list of attendees.

1.3 **PREREQUISITES TO DEMONSTRATION AND TRAINING**

- .1 Testing, adjusting and balancing has been performed in accordance with Contract Documents.
- .2 Equipment and systems are fully operational.
- .3 Copy of completed operation and maintenance manual is available for use in demonstration and training.
- .4 Conditions for demonstration and training comply with requirements specified in technical Specifications.

1.4 **DEMONSTRATION AND TRAINING**

- .1 Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, and maintenance of each item of equipment and system.
- .2 Review operation and maintenance manual in detail to explain aspects of operation and maintenance.
- .3 Prepare and insert additional information in operation and maintenance manual if required.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 General behavioral health performance requirements that apply to post-construction performance of Work specified in other Specification Sections.
- .2 Provisions of this Section apply to medium and high-risk treatment areas.
- .3 Related Requirements: Refer to Division 01 Section "Special Project Procedures for Behavioral Health Facilities" for administrative requirements and identification of Behavioral Health Facility Specialist/Coordinator.
- .4 Guidelines and Standards: Design Guide for the Built Environment of Behavioral Health Facilities. Distributed by the Facilities Guidelines Institute (FGI) National Association of Psychiatric Health Systems; (Canada) latest version.

1.2 **PERFORMANCE REQUIREMENTS**

- .1 General: Comply with the requirements of this Section unless individual technical Sections include more stringent requirements.
- .2 General: Provide tamper-resistant fasteners at locations and for Products, devices and assemblies, where the fastener is exposed to touch by a patient. This includes fasteners that could be reached by patients by removing an otherwise unsecured protective covering or panel. Tamper-resistant fasteners shall be hexalobular type head with center pin, requiring a unique tool for removal.
- .3 Human-Impact Resistance: For human-impact-resistance assemblies, including partitions, provide materials and construction identical to those tested in assembly indicated according to ASTM E 695 shall withstand impact loading by blunt object of 2000 ft.-lb. (271 Nm).
- .4 Division 07 - Thermal and Moisture Protection:
 - .1 Security Sealants - Tamper Resistant:
 - .1 Sealants meeting ASTM C290.
 - .2 Provide security grade sealants at inpatient areas. Tamper resistant sealants are suitable for supervised locations.
 - .3 Tamper resistant sealants are generally flexible, abrasion resistant and highly tenacious. They're usually based on urethane or silicone sealant technology, in both one (1) and two (2) component formulas.
- .5 Division 08 – Openings:
 - .1 Doors - Glazed Lites:
 - .1 Heat-Strengthened and Laminated Glazing: 1" continuous edge bite if dry glazed or ½" continuous edge bite if silicone glazed.
 - .2 Observation Windows: Glazing stops providing 5/8" continuous edge bite or ½" continuous edge bite with structural silicone sealant at full perimeter.
 - .3 Impact Requirements: Comply with 2,000 ft-lb impact test determined by NYS-OMH and AAMA 501.8 Standard Test Method for Determination of Resistance to Human Impact of Window Systems Intended for Use in Psychiatric Applications.

- .2 Door Hardware - Continuous Hinges:
 - .1 Provide continuous hinges for in-swinging and out-swinging doors within inpatient units.
 - .2 Provide Hospital Tips (HT) to eliminate ligature point at top of hinge.
 - .3 Prepare and reinforce door frame in strict compliance with hardware manufacturer's written instructions and installation templates.
- .3 Door Hardware - Locks and Handles:
 - .1 Provide tamper resistant, flush mounted set screws. A recessed set screw shaft provides a ligature opportunity for the stiff end of a shoelace.
 - .2 Beveled latch bolts can be compromised, permitting access to rooms and therefore should never be used on doors to potentially hazardous locations such as electrical rooms and housekeeping closets.
 - .3 Provide a two (2) piece stainless steel mechanical anti-friction latchbolt for staff-only rooms and other areas identified as low or medium risk.
- .4 Door Hardware - Lever Handles:
 - .1 Identify locations of this door trim type on the Project and review with the Consultant prior to ordering and installing.
 - .2 Lever style door trim is not appropriate for high-risk areas.
- .5 Door Hardware - Privacy Thumbturns:
 - .1 Institutional privacy locksets utilize privacy thumbturns. There are five (5) key criteria for a successful assembly. Listed below each Product are notes identifying whether each criterion is met. The criteria are as follows:
 - i. Ligature resistance.
 - ii. Release of lock upon door closure.
 - iii. Outside key override of thumbturn.
 - iv. Outside locking of door by key.
 - v. Compliance with governing accessibility requirements.
 - .2 Provide only tamper resistant, flush mounted set screws. A recessed set screw shaft provides a ligature opportunity for the stiff end of a shoelace.
- .6 Door Hardware - Pulls: Provide only tamper resistant, flush mounted set screws. A recessed set screw shaft can provide a ligature opportunity for the stiff end of a shoelace.
- .6 Door Hardware - Stops:
 - .1 Provide wall mounted door stops based upon doorknob/lever type and be mechanically fastened to resist twist off. Stops shall be installed with solid wood blocking behind and with construction adhesive applied to backside of the base plate prior to mechanical attachment with tamper resistant fasteners. Sealant shall be applied around the perimeter of the stop.
 - .2 Caution While Observing: Traditional style doorstops do not have concealed fasteners with a clamping ring to secure the stop. These can be removed by hand and ingested.

- .7 Door Hardware - Closers:
 - .1 Mount closers on public side of doors to rooms with patient access or on the secure side of doors that need to automatically lock or latch, such as storerooms, Soiled utility rooms and doors with card access readers. Provide concealed closers in patient accessible area or where risk assessment indicates that surface mounted closers are not acceptable.
 - .2 Gap tolerance at top to be 1/8" maximum. Doors with concealed closers that are intended to receive door top sensors must use a face mounted sensor to avoid conflict with the closer arm.
 - .3 Identify locations of door closers on the Project and review with the Consultant prior to ordering and installing.
- .8 Door Hardware - Gasketing:
 - .1 Identify locations of gasketing on the Project and review with the Consultant prior to ordering and installing.
 - .2 Where door bottom gasketing is called for, utilize fully recessed door sweeps that are mechanically fastened to the door slab.
- .9 Glazing - General:
 - .1 For laminated glazing, install in frame systems with 1" continuous edge bite if dry glazed or 1/2" continuous edge bite if silicone glazed.
 - .2 For observation windows, install glazing in a frame with glazing stops that provide 5/8" continuous edge bite or a 1/2" continuous edge bite with structural silicone sealant at the full perimeter.
 - .3 Comply with 2,000 ft-lb impact test as determined by NYS-OMH and AAMA 501.8 Standard Test Method for Determination of Resistance to Human Impact of Window Systems Intended for Use in Psychiatric Applications.
- .10 Glazing - Exterior Windows, Where indicated provide polycarbonate glazing laminated safety glazing:
 - .1 Where indicated on Drawings, provide windows with sash, frame and glazing capable of withstanding 2,000 ft-lb impact loads from a 1'-0" diameter impact object without breach, dislodging or breakage.
 - .2 Integral / concealed blinds to be utilized as the solar control mechanism, installed between the sill sash and the inner lite of the insulated glazing unit (IGU).
 - .3 Do not use low profile, side mount angled or vertical mount angled operators for concealed operable blinds because they create ligature points.
- .11 Glazing within Aluminum Patient Windows and Patient Care Areas: Glass used to provide a guard or as a portion of the guard system must comply with Section 2407 of International Building Code; latest adopted edition. Where the glazing provided does not meet the strength and attachment requirements of Section 16 07 .8 of International Building Code; latest adopted edition, complying guards must be provided along glazed sides of open-sided walking surfaces
- .12 Glazing - Interior Windows, Non-Rated:
 - .1 1/2" polycarbonate is recommended where ingesting, laceration and weaponization are the risks to be mitigated.
 - .2 1/2" polycarbonate is recommended where escape or jumping are the risks to be mitigated.

- .3 Heat-strengthened (or tempered), plus laminated safety glazing, other than the laminate specifically identified, should not be used without review with the Consultant.
- .13 Anti-Spall Window Films:
 - .1 Anti-spall films applied to conventional glazing to prevent shards in the event of failure. Films may prevent off-sharding, laceration, weaponizing and ingestion. Anti-spall films may provide a cost-effective safety improvement for pre-existing conventional glazing materials by increasing the penetration resistance of any thickness of glass.
 - .2 Extend film to edge of glazing beyond the face of the glazing bead/stop.
- .14 Glazing - Interior Windows, Fire Rated:
 - .1 Do not use wire glazing in any applications.
 - .2 For One (1) Hour Openings: Use 3/8" polycarbonate in conjunction with sprinkler heads and 5/8" stops where the authority having jurisdiction will accept NYS-OMH's Warnock Hersey test (not tested per ASTM F1233). Or Provide fire rated glazing clad with 1/4" polycarbonate on each side accessible to patients.
- .15 Glazing - Observation Mirrors (provide either of the following installations):
 - .1 Install glazing in a hollow metal frame with glazing stops that provide a 5/8" continuous edge bite.
 - .2 Install glazing in a hollow metal frame with glazing stops that provide a 1/2" continuous edge bite with structural silicone sealant at the full perimeter.
- .16 Access Doors:
 - .1 Avoid the use of access doors in patient areas to the greatest extent possible, particularly in unsupervised areas such as patient bedrooms and bathrooms.
 - .2 Access door frames shall be minimum 16-gauge steel. Access door shall be minimum 20-gauge steel, welded pan type. Door flange shall be 1" wide minimum, for embedment in drywall compound. Hinges shall be continuous. Base metal shall be steel with primer coat of rust inhibitive electrostatic powder baked gray enamel or stainless steel.
 - .3 The access door may be filled with fire rated insulation. The door shall be automatic closing, self-latching and contain an interior latch release.
 - .4 Locks shall be mortise slam latch with keyed cylinder. Locks shall be keyed alike.
- .17 Division 09 – Finishes:
 - .1 Wall Base:
 - .1 Use only heat welded integral cove base, solid wood or prefinished rubber/PVC base. Identify locations of other base types on the Project and review with the Consultant prior to ordering and installing
 - .2 Integral Cove Base: Adhere base to wall. Provide tamper resistant sealant along the top edge of base.
 - .3 Rubber Wall Base: Adhere and mechanically fasten base to wall. Fasteners shall be screwed into wood blocking, countersunk and filled.
 - .4 Shop Drawing Preparation: Review with the Consultant the locations of conventional commercial vinyl or rubber wall base in patient areas, prior to order of Products, these Products are easily removable, presenting risk of weaponization.

- .2 Linear Metal Ceilings:
 - .1 Ceiling panels are not removable and access doors need to be installed to provide access above the ceiling.
 - .2 Ceiling panels shall be mechanically fastened with tamper resistant fasteners, even interlocking panels.
 - .3 Select steel gauge based on finished ceiling heights and risk levels of installation areas.
- .18 Division 10 – Specialties:
 - .1 Handrails:
 - .1 Handrails are subject to possible wedge ligature with a shoe or other object.
 - .2 Verify that handrails are installed in strict accordance with the manufacturer's installation instructions. Proper installation is critical for tight tolerances between the multiple product pieces.
 - .3 Security tamper resistant sealant will be required to fill voids around the perimeter of handrails and grab bars depending on installation substrate, review locations with the Consultant.
 - .4 The inside of handrails with continuous mounting brackets are susceptible to the collection of debris.
 - .5 Traditional code compliant handrails create obvious ligature opportunities - identify handrails without special provisions for behavioral health care environments.
 - .2 Shower and Privacy Curtains:
 - .1 Material tests should include verifying fabrics in both wet and dry conditions, which can affect asphyxiation.
 - .2 Provide breathable fabric material for shower and privacy curtains.
 - .3 Recessed ceiling track (if specified) shall run continuously between walls. Surface mounted ceiling track (if specified) shall run continuously between walls or be installed with secure end caps. Fill joints between sections of track with tamper resistant sealant to reduce opportunities for ligature.
 - .4 Review the following with the Consultant when discovered in Contract Documents or in-field, prior to proceeding:
 - i. End caps can create opportunity for a wedge ligature.
 - ii. A looping point can be created in curtain tracks when an object, such as a penny, is inserted into the track, this is inherent to a track system and the Project Owner should be notified and advised of risks.
 - iii. The breakaway weight for curtain carriers may exceed limits at which self-harm can be induced. Provide minimal carriers so that they cannot be ganged together to increase the release weight.
 - .3 Toilet Accessories and Hand Dryers - General:
 - .1 Best practice advocates the use of recessed toilet accessories.
 - .2 Quality control of toilet accessories is important and often difficult to control. Samples should be requested as part of the submittal process.

- .3 Front mounted models should be installed with tamper resistant fasteners. Back mounted models can only be installed on accessible chase walls.
- .4 Closet Rods, Clothes and Towel / Robe Hooks:
 - .1 No closet rods are to be provided within patient areas.
 - .2 Towel / Robe hooks shall only be those approved for use by NYS OMH.
- .5 Grab Bars - General:
 - .1 Grab bars should only be installed where required by code.
 - .2 Verify that grab bars are installed per the manufacturer's installation instructions. Proper installation is critical for tight tolerances between the multiple product pieces.
 - .3 Security tamper resistant sealant may be required to fill voids around the perimeter of grab bars depending on installation substrate, review locations with the Consultant.
- .6 Toilet Accessories - Grab Bars:
 - .1 Grab bars are subject to possible wedge ligature with a shoe or other object. Grab bars should only be installed where required by code.
 - .2 Specify Type 316 stainless steel for wet locations when available.
 - .3 Verify that grab bars are installed per the manufacturer's installation instructions. Proper installation is critical for tight tolerances between the multiple product pieces.
 - .4 Provide continuous blocking. Be attentive to potential moment arm issues on existing installations without continuous blocking.
 - .5 Security tamper resistant sealant may be required to fill voids around the perimeter of grab bars depending on the installation substrate.
 - .6 Specialty grab bars may be handed in only one (1) direction when installed vertically.
 - .7 Review the following with the Consultant when discovered in Contract Documents or in-field, prior to proceeding:
 - i. Traditional code compliant grab bars create obvious ligature opportunities.
 - ii. Drainage holes at end caps create potential ligature opportunities with paper clips, provide grab bars with specialty / integrated drainage design.
- .7 Toilet Accessories - Soap Dispensers: Shop Drawing Preparation: Review with the Consultant the use soap dispensers with flat tops or push levers that may provide a loopable ligature, prior to order of Products.
- .8 Toilet Accessories - Paper Towel Holders and Dispensers:
 - .1 Recessed paper towel shelves require blocking on sides of shelf at wall studs and shall be mechanically through to blocking.
 - .2 Provide required wall thickness for recessed toilet accessories.

- .9 Toilet Accessories - Toilet Tissue Holders and Dispensers:
 - .1 Review the following with the Consultant when discovered in Contract Documents or in-field, prior to proceeding:
 - i. Potential hazard with loose toilet tissue rolls which can be lodged in toilets.
 - ii. Potential infection control issue with loose toilet tissue rolls which can be easily dropped on the floor.
 - iii. Toilet tissue holders with spindles may allow a downward ligature by tying off to the spindles if they don't release when more than the acceptable amount of force is applied (greater than 11 lbs.).
- .10 Toilet Accessories - Mirrors: Only polycarbonate or polished stainless-steel glazing is recommended for use in patient bathrooms. Refer to appropriate Specification Section for permitted materials on this Project.
- .11 Window Treatments:
 - .1 Recessed ceiling track must run continuously between walls. Surface mounted ceiling track shall run continuously between walls or be installed with secure end caps. Jambs. Fill joints between sections of track with tamper resistant sealant to reduce opportunities for ligature.
 - .2 Review the following with the Consultant when discovered in Contract Documents or in-field, prior to proceeding:
 - i. End caps can create opportunity for a wedge ligature.
 - ii. A looping point can be created in curtain tracks when an object, such as a penny, is inserted into the track.
 - iii. The breakaway weight for curtain carriers may exceed the limits at which self-harm can be induced. Carriers can be ganged together to increase the release weight.
- .12 Cabinet Hardware:
 - .1 For cabinet and dresser doors and drawers, provide either ligature resistant pulls or integral recessed flush pulls.
 - .2 Provide non-loopable ligature resistant, tamper resistant security grade hardware. Ensure cabinet hinge pin is not removable (tack weld or cap).
 - .3 Single point fasteners pose twist off hazard; provide set screw or embed fastener in pick proof sealant.
- .13 Signage: Signage systems should be mechanically fastened to substrate with tamper resistant fasteners. Double stick tape and Velcro are not acceptable.
- .14 Fire Extinguisher Cabinets:
 - .1 Locate only in supervised areas.
 - .2 NFPA 10 requires locking fire extinguisher cabinets to include a "means of emergency access". Manufacturers interpret this in various ways, including:
 - i. Full lock with staff assigned keys.
 - ii. Break-away latch/lock with resettable tongue.
 - iii. Break-away latch/lock with non-re-settable tongue.

- .3 Carefully review non-resettable Products before specifying, as actual damage may be caused to the latch/lock mechanism during emergency access. Repair may be simple or complex depending on the specific Product.
- .4 Fire extinguisher cabinets are tested primarily for abuse-resistance and may be loopable at cabinet/door joint.
- .19 Division 12 – Furnishings:
 - .1 Furniture - General:
 - .1 Doors and Drawers Guidelines:
 - i. Provide locks for doors and drawers.
 - ii. Provide doors with continuous hinges and hospital tips.
 - iii. Provide doors with recessed ligature resistant finger pulls. If available, continuous integral finger pulls can also be provided.
 - iv. Provide drawers with recessed ligature resistant finger pulls, stops and locks.
 - v. For high-risk patients, provide built-in closets with door top ligature sensors.
 - .2 Wardrobe and Closet Unit Guidelines:
 - i. Recess wardrobes and closet units or make continuous to underside of ceilings or soffits above.
 - ii. When it's not possible to make recessed units or make them continuous to underside of ceilings or soffits above, provide sloped tops.
 - iii. Provide collapsible coat hooks. Closet rods and J-bars are not acceptable.
 - iv. Shelves for folded garments shall be used instead of arrangements for hanging garments.
 - .3 Platform Bed Guidelines:
 - i. Beds to be platform type with flush side panels, headboards and footboards, with no overlapping lips between members.
 - ii. Platform beds to be six (6) sided and have an enclosed bottom or be five (5) sided and bolted to the floor.
 - iii. Provide solid wood or minimum $\frac{3}{4}$ " plywood panels with veneer. Particleboard and plastic laminate are not acceptable.
 - iv. Members, both exposed and internal, to be sealed with three (3) layers of polyurethane.
 - v. Internal construction shall consist of at least two (2) intermediate supports. Acceptable support materials are wood and metal.
 - vi. Top and edge joints to be sealed with tamper resistant sealant.
 - vii. Provide no exposed fasteners, except when fastening bed to the floor.
 - viii. Glides and adjustable feet are not acceptable. Felt pads only.

- ix. Exercise caution with platform beds that have restraints. These should be removed in patient rooms unless one (1) on one (1) supervision is provided.
 - x. Each facility must perform their own risk assessment to evaluate Products.
 - xi. Wood platform beds shall be six (6) sided and joints shall be sealed with tamper-resistant sealant.
- .20 Division 21 - Fire Suppression:
- .1 Sprinklers:
 - .2 Provide only tamper-resistant concealed heads specifically designed for high-risk patient environments; must be accepted by NYS OMH Guidelines.
 - .3 Provide no accessible parts that activate the sprinkler system when vandalized.
- .21 Division 22 – Plumbing:
- .1 Lavatory Assemblies:
 - .1 Use of wall-hung lavatories with engaged vanity counters are ligature resistant only when engaged side to side by knee walls or niches. Wall-hung lavatories are discouraged.
 - .2 Solid surface integral, countertop mounted and undermount lavatories are preferred and acceptable when overall assembly is designed to be non-loopable.
 - .3 Provide barrier-free compliant handicapped accessible lavatory assembly configurations where required.
 - .2 Lavatory Basins:
 - .1 Solid surface integral, countertop mounted and undermount lavatories are acceptable when part of assembly that is itself designed to be non-loopable.
 - .2 Use of lavatories with engaged vanity counters are ligature resistant when engaged side to side by knee walls or niches.
 - .3 Provide barrier-free compliant handicapped accessible lavatory assembly configurations where required.
 - .3 Lavatory Pipe Enclosures: Provide tamper resistant fasteners.
 - .4 Lavatory Faucets:
 - .1 Faucets must be considered as part of the entire assembly.
 - .2 Provide projecting spouts only when the lavatory is positioned so that the lateral ligature hang is not possible (i.e., recessed in a niche).
 - .3 Lavatory Grid Strainers: Review the following with the Consultant when discovered in Contract Documents or in-field, prior to proceeding:
 - i. Fixed type strainers must be provided, with no moving parts. Drainage holes should be no more than one half (½) the diameter as typical grid strainers, making threading of a thin ligature difficult.

- .5 Toilets:
 - .1 Due to the possibility of inappropriate behavior, provide 1.6 gpf siphon jet toilets.
 - .2 The wall surface must be flush with the toilet to avoid gaps that can become ligature points.
 - .3 Provide standard toilets with heavy duty carriers. Where specified, bariatric toilets should be specified with bariatric carriers. Coordinate with manufacturers for specific carrier model specifications.
 - .4 Floor mounted toilets must be provided with complete closure between the toilet and wall / floor to reduce ligature opportunities.
 - .5 Review the following with the Consultant when discovered in Contract Documents or in-field, prior to proceeding, toilet seats that are not integral with the bowl create ligature opportunities, toilets must have integral seats and no lids.
- .6 Toilet Flushometers:
 - .1 Provide concealed flush valves with remote infrared sensor controls reduce looping ligature opportunities.
 - .2 Access doors and infrared sensor cover plates must be fully recessed so that faces are flush with the adjacent finish materials. This is to avoid exposed sharp corners, potential picking at edges and possible ligature points. If the toilet is positioned such that the pipe chase is on a wall that is shared with the corridor, the access panel should be considered in the corridor rather than the washroom.
 - .3 When conflicts with barrier-free required grab bars occur, provide offset concealed flush valves.
 - .4 If wall finish is ceramic tile, provide an access door with plaster frame to allow the door installation to be flush with the ceramic tile surface.
 - .5 Manufacturer supplied infrared cover plates may be designed for surface mounting and may require customization to provide a flush installation.
 - .6 Acceptable flush valve manufacturers indicate an ability to assemble offset installations to avoid conflicts with grab bars. Verify with each manufacturer the specific requirements for offset plumbing extensions, access door size and positioning and remote infrared sensor connections and cover plate dimensions.
- .7 Toilet Flush Valve Covers: Confirm that the flush valve covers fit the existing flush valve assemblies well enough to allow for free operation of the equipment, without providing a potential ligature point through the opening for the flushing mechanism.
- .8 Where indicated provide Hydration Stations:
 - .1 A remote cooler is required for chilled water dispensing and a drainage system is required for wastewater.
 - .2 The top of the hydration station access door must be sloped.
 - .3 Drain grilles must be securely fastened with tamper resistant fasteners. Integral cup dispensers must be securely fastened to the hydration station housing.
- .9 Shower Heads: Provide ligature resistant shower heads.

- .10 Hand Showers:
 - .1 If specified, hand showers shall be installed in addition to a primary ligature resistant shower head.
 - .2 When a fixed shower head and hand shower are both used, provide either a ligature resistant diverter valve or separate ligature resistant control systems for each fixture.
 - .3 Tie-off ligature opportunity exists at hose bib. Hand showers must be installed on wall as low as permissible by regulations to minimize risk.
- .11 Shower Controls and Activators: Provide shower controls that are ligature-resistant and offer functionality as specified in the plumbing Sections. This may include controllers limiting water flow duration and/or temperature control set by staff or adjustable by patients.
- .22 Division 23 – HVAC:
 - .1 Diffusers and Grilles:
 - .1 Louver and grille opening size and spacing is a critical consideration for structural performance, air flow and ligature resistance. The most secure and ligature resistant assemblies are typically very heavy, requiring careful consideration for structural support and the sequence of construction.
 - .2 Perforated radiator covers pose a particular risk as they can be looped by a thin shoelace or similar object. Because these enclosures are typically surface mounted, careful consideration must be given to the installation conditions at these covers to prevent wedging/looping opportunities at the installed substrate. Tamper resistant sealant must be utilized to close gaps at perimeter of enclosure.
 - .3 Diffusers and grilles must be securely mounted in place using tamper resistant fasteners. Diffusers and grilles and accessible elements of the housing should be attached to permanently affixed concealed back angles that are part of the assembly or to wall or ceiling framing elements.
 - .4 Escape Prevention:
 - i. If diffusers and grilles are required to be large enough to allow passage, they shall be securely mounted in place using welded joints and/or tamper resistant fasteners.
 - ii. Diffusers, grilles and accessible elements of housing should be attached to wall or ceiling framing elements and to the ductwork.
 - iii. Face plate construction shall be thick enough to resist impact assaults and shall not be removable, except with special tamper resistant fastener tools.
 - iv. Passage restrictors shall be permanently welded in the sleeve housing within the assemblies.
 - .5 Ligature Resistance:
 - i. Where ligature resistance is a primary risk criterion, provide diffusers and grilles with closely spaced welded deep “S” and “Z” shaped vanes that prevent looping or they should be protected by heavy gauge metal face plates with small, tightly spaced, perforated holes. Perforated grilles with holes no larger than 1/8” in diameter on staggered centers have been tested and have resisted looping.

- ii. Perforated diffusers, grilles and radiator covers utilizing the industry standard of 3/16" hole on 9/32" spacing pose a particular risk as they can be easily looped by a thin shoelace or similar object. Because these devices are prevalent in existing inpatient environments, they are acceptable in low and medium risk environments only. Review with the Consultant, locations within high-risk environments indicated for this type, prior to order of Products.
 - .6 Concealed Contraband Prevention:
 - i. Where concealing contraband is a primary risk criterion, diffusers and grilles must be reduced in size to the greatest extent possible and securely mounted in place using tamper resistant fasteners.
 - ii. Diffusers and grilles and accessible elements of the housing must be attached to wall or ceiling framing elements.
 - iii. Face plate construction must be thick enough to resist impact assaults and must not be removable, except with special tamper resistant fastener tools.
 - .2 Thermostats: Provide covers and/or flat plate digital thermostats in high-risk areas.
- .23 Division 26 – Electrical:
- .1 Receptacles and Switches - General:
 - .1 Fasten cover plates to receptacle with tamper resistant fasteners that are accepted in the NYS-OMH Patient Safety Standards. Two (2) fasteners are recommended, though not required, for cover plates.
 - .2 Provide tamper resistant receptacles with arc fault and ground fault interruption in patient accessible areas of psychiatric hospitals and wards.
 - .2 Receptacles and GFCI/AFCI Circuit Breakers:
 - .1 Provide dual function circuit breakers for circuits with devices in patient accessible areas.
 - .2 Circuit breakers are to be located within secure electrical panels beyond the patient environment.
 - .3 Wall Plates: Provide thermoplastic nylon wall plates.
 - .4 Sensors: Provide ceiling mounted sensors, in designated rooms.
 - .5 Light Fixtures - Interior Night Lighting:
 - .1 Provide amber colored LEDs patient bedrooms.
 - .2 Provide recessed night lights at approximately 1'-0" to 1'-6" above finish floor for proper use and to minimize potential ligature risk.
 - .6 Light Fixtures - Exit Signage:
 - .1 Must be positively and mechanically attached, not friction fit.
 - .2 Provide with UL listed 924 (NEC, NFPA 70) and mount flush to walls or ceilings.
 - .3 Provide with fully recessed housing.

- .24 Division 27 – Communications:
 - .1 Wireless Routers:
 - .1 Wireless routers to be mounted above the ceiling systems in medium and high-risk areas.
 - .2 Wireless routers can be mounted below the ceiling systems only in low-risk areas.
 - .2 Clocks: Provide recessed wall clocks with polycarbonate lenses.
- .25 Division 28 - Electronic Safety and Security:
 - .1 Fire Alarm Components - General:
 - .1 Fire alarm notification devices are required to be ceiling mounted in high-risk areas.
 - .2 It is recommended that fire alarm notification devices be ceiling mounted in medium risk areas.
 - .2 Fire Alarm Comments - Notification Devices:
 - .1 Fire alarm notification devices are required to be ceiling mounted in high-risk areas.
 - .2 It is recommended that fire alarm notification devices be ceiling mounted in medium risk areas.
 - .3 Review the following with the Consultant when discovered in Contract Documents or in-field, prior to proceeding: Device covers are susceptible to abuse and can be looped/weaponized.

Part 2 Products - Not Used, see individual Specification Sections.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Certify the Mental Health Construction Coordinator, defined by Section 01 35 13.53, has reviewed performance requirements of this Section during applicable pre-installation conferences throughout the duration of the Project. Review conflicts with these requirements prior to proceeding with Work.
- .2 Certify that behavioral health Products, systems, sub-systems and construction have been completed in accordance with the requirements of the Contract Documents.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Commissioning, testing and documentation.

1.2 **COMMISSIONING AGENCY**

- .1 *Contractor* shall retain and pay for a commissioning agency to provide commissioning services for the *Project*.

1.3 **CONTRACTOR RESPONSIBILITIES**

- .1 Prepare each system ready for commissioning. Verify systems installation is complete and in operation.
- .2 Coordinate commissioning with and assist commissioning agency.
- .3 Perform and document verification, performance testing, adjusting and balancing operations.
- .4 Cooperate with commissioning agency and provide access to equipment and systems.
- .5 Provide personnel and operate systems at designated times and under conditions required for proper commissioning.
- .6 Make instruments available to commissioning agency to facilitate spot checks during commissioning.
- .7 Participate in commissioning meetings.
- .8 Complete commissioning forms as requested by commissioning agency.
- .9 Correct deficiencies identified in commissioning process.
- .10 Incorporate commissioning data into operation and maintenance manual.
- .11 Ensure that commissioning agency participates in demonstration and training as specified in Section 01 79 00 – Demonstration and Training.
- .12 Provide instruments necessary for commissioning.

1.4 **COMMISSIONING AGENCY RESPONSIBILITIES**

- .1 The commissioning agency will:
 - .1 Prepare a commissioning plan, including systems to be commissioned, forms, checklists and responsibilities of commissioning team members.
 - .2 Implement the commissioning plan and lead the commissioning team through start-up, verification, performance testing, training and document preparation.
 - .3 Convene, chair, prepare and distribute minutes of commissioning meetings.
 - .4 Supervise commissioning activities and witness inspections and tests.
 - .5 Make periodic *Project* site visits for the purpose of selective checking of accuracy of commissioning form submissions, witness testing and review of mock-ups.
 - .6 Review content of operations and maintenance manual.
 - .7 Provide instruments necessary for commissioning.

1.5 CONSULTANT RESPONSIBILITIES

.1 Consultant will:

- .1 Participate in commissioning meetings.
- .2 Coordinate commissioning agency's involvement in *Shop Drawing* review process.
- .3 Review verification and performance test results and direct *Contractor* to correct defects or deficiencies in the *Work*.
- .4 Initiate *Change Orders* or *Change Directives* identified as necessary by the commissioning process.
- .5 Review final commissioning report.

1.6 OWNER RESPONSIBILITIES

.1 Owner will:

- .1 Assign operations and maintenance personnel to participate in meetings and witnessing of demonstration and training.
- .2 Designate a person to acknowledge receipt of reports.

1.7 SCHEDULE OF EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

- .1 Division 21 – Fire Suppression.
- .2 Division 23 – Heating, Ventilating, and Air Conditioning (HVAC).
- .3 Division 28 – Electronic Safety and Security.

Part 2 Products – Not Used

Part 3 Execution – Not Used

END OF DOCUMENT

Part 1 General

1.1 **SECTION INCLUDES**

- .1 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 **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.
- .2 Remove and Salvage: Detach items from existing construction ready for reuse.
- .3 Remove and Reinstall: Detach items from existing construction, prepare them for reuse and reinstall them where indicated.
- .4 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed, removed and salvaged or removed and reinstalled.
- .5 Waste Management Coordinator (WMC): Contractor representative responsible for supervising waste management activities as well as coordinating related, required submittal and reporting requirements.
- .6 Draft Construction Waste Management Plan (Draft CWM Plan):
 - .1 Detailed inventory of materials in building indicating estimated quantities of reuse, recycling and landfill, prepared in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .2 And involves quantifying by volume/weight amounts of materials and wastes generated during construction, demolition, deconstruction or renovation project.
- .7 Construction Waste Management Plan (CWM Plan): Written plan addressing opportunities for reduction, reuse or recycling of materials prepared in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .8 Construction Waste Management Report (CWM Report): Written report identifying actual materials that formed CWM Plan for reduction, reuse or recycling of materials prepared in accordance with Section 01 74 19 - Waste Management and Disposal.
- .9 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.3 **ADMINISTRATIVE REQUIREMENTS**

- .1 Coordinate with Consultant and/or Owner for the material ownership as follows:
 - .1 Except for items or materials indicated to be reused, salvaged, reinstalled or otherwise indicated to remain by the Consultant and/or Owner's, demolished materials shall become Contractor's property and shall be removed from Project site.

- .2 Coordinate selective demolition work so that *Work* of this Section adheres to aesthetic criteria established by the Drawings and specified dimensions with elements in planes as drawn, maintaining their relationships with other building elements.
- .3 Historic items, relics and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques and other items of interest or value to the Owner that may be encountered during selective demolition remain the Owner's property:
 - .1 Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.
 - .2 Coordinate with Consultant and/or Owner, who will establish special procedures for removal and salvage.
- .2 Pre-Demolition Meeting: Convene pre-installation meeting one (1) week prior to beginning *Work* of this Section and on-site installation, with Contractor and Consultant in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Confirm extent of salvaged and demolished materials
 - .2 Review Contractor's demolition plan:
 - .1 Verify existing site conditions adjacent to demolition work
 - .2 Coordination with other construction sub trades
- .3 Hold Project meetings as scheduled by the Consultant.
- .4 Ensure key personnel, site supervisor, project manager, subcontractor representatives and WMC attend.
- .5 WMC must provide written report on status of waste diversion activity at each meeting.
- .6 Consultant will provide written notification of change to meeting schedule established upon contract award twenty-four (24) hours prior to scheduled meeting.

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following submittals before starting *Work* of this Section:
 - .1 Schedule of Selective Demolition Activities: Coordinate with Section 01 32 00 - Construction Progress Documentation and indicate the following:
 - .1 Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
 - .2 Coordinate with the Consultant and building manager and ongoing site operations and limit the number of interruptions during regular business hours.
 - .3 Interruption of utility services.
 - .4 Coordination for shutoff, capping and continuation of utility services.
 - .5 Use of elevator and stairs.
 - .6 Locations of temporary partitions and means of egress, including for others affected by selective demolition operations.
 - .7 Coordination with Consultant regarding Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed *Work*.

- .2 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 in accordance with requirements of authority having jurisdiction (AHJ) 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 operation.
 - .2 Inventory: Submit a list of items that have been removed and salvaged after selective demolition is complete.
 - .3 Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
 - .4 Pre-demolition Photographs or Videotape: Submit photographs or videotape 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.
- .2 Provide the following Qualification Data when requested by the Consultant: 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.

1.5 **QUALITY ASSURANCE**

- .1 Regulatory Requirements: Perform work as follows; use most restrictive requirements where differences occur between the municipal, provincial and federal jurisdictions:
 - .1 Provincial and Federal Requirements: Perform Work in accordance with governing environmental notification requirements and regulations of the AHJ.
 - .2 Municipal Requirements: Perform hauling and disposal operations in accordance with regulations of AHJ.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .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 provincial Occupational Health and Safety Act and Regulation.
 - .2 Conform to Workers' Compensation Board Regulations.
 - .3 Conform to City of local municipal bylaws and regulations governing this type of work.

1.6 **SITE CONDITIONS**

- .1 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 seventy-two (72) hours' notice to Owner of activities that will affect Owner's operations.

- .2 Maintain access to existing means of egress, walkways, corridors, exits and other adjacent occupied or used facilities. Do not close or obstruct means of egress, walkways, corridors, exits or other occupied or used facilities without written acceptance from authorities having jurisdiction.
- .3 Consultant and Owner assume no responsibility for condition of areas to be selectively demolished:
 - .1 Conditions existing at time of pre bid Project site review will be maintained by Owner as far as practical.
 - .2 Owner may remove the items prior to selective demolition.
- .4 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in the Work; immediately notify Consultant if materials suspected of containing hazardous substances are encountered and perform the following activities:
 - .1 Refer to Section 01 40 00 - Quality Requirements for directives associated with specific material types.
 - .2 Hazardous materials will be as defined in the Hazardous Materials Act.
 - .3 Hazardous materials will be removed start of the Work.
 - .4 If materials suspected of containing hazardous materials are encountered, do not disturb, immediately notify Consultant. Hazardous materials will be removed by Owner under a separate contract or as a change to the Work.

Part 2 Products

2.1 **TEMPORARY SUPPORT STRUCTURES**

- .1 Design temporary support structures required for demolition work and underpinning and other foundation supports necessary for the Project using a qualified professional engineer registered or licensed in province of the Work.

2.2 **DESCRIPTION**

- .1 This Section of the Work includes, but is not necessarily limited to, the following:
 - .1 Demolition, removal completely from the Project site and disposal of identified components, materials, equipment and debris.
 - .2 Selective demolition to allow new walls, bulkheads, ceilings and other materials to meet existing construction as indicated.
 - .3 Material from demolition shall be removed from Project site immediately with no salvage, selling, sorting or burning permitted on Project site.
 - .4 Retain items indicated on Drawings for re use in new construction.

2.3 **DEBRIS**

- .1 Arrange for transport and disposal of demolished materials from the Project site.

2.4 **EQUIPMENT**

- .1 Provide equipment required for safe and proper demolition of the building interiors indicated.

2.5 REPAIR MATERIALS

- .1 Use repair materials identical to existing materials:
 - .1 If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 - .2 Use a material whose installed performance equals or surpasses that of existing material.
 - .3 Comply with material and installation requirements specified in individual Specification Sections.
- .2 Floor Patching and Levelling Compounds: Cement based, trowelable, self levelling compounds compatible with specified floor finishes; gypsum-based Products are not acceptable for Work of this Section.
- .3 Concrete Unit Masonry: Lightweight concrete masonry units and mortar, cut and trimmed to fit existing opening to be filled. Provide standard hollow core units, square end units and bond beam units as indicated on drawings.
- .4 Prefinished Sheet Steel: Prefinished sheet steel, colour to match existing radiation cabinets, bent and profiled to match existing radiation cabinets.
- .5 Gypsum Board Patching Compounds: Joint compound to ASTM C475/C475M, bedding and finishing types thinned to provide skim coat consistency to patch and prepare existing gypsum board walls ready for new finishes in accordance with Section 09 21 16 - Gypsum Board Assemblies
- .6 Hoarding and Dust Screens: Refer to Section 01 56 00 - Temporary Barriers and Enclosures for stud framing and gypsum board sheathing materials.

2.6 EXISTING MATERIALS

- .1 Some items will be retained for re-use in new construction: Confirm with Consultant materials scheduled for re-use that are not in re-usable condition prior to installation.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that utilities have been disconnected and capped.
- .2 Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- .3 Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- .4 Notify the Consultant where existing mechanical, electrical or structural 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.
- .5 Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

- .1 Coordinate existing services indicated to remain and protect them against damage during selective demolition operations.
- .2 Locate, identify, disconnect and seal or cap off indicated utilities serving areas to be selectively demolished.
 - .1 Arrange to shut off affected utilities with utility companies.
 - .2 If utility services are required to be removed, relocated or abandoned, before proceeding with demolition provide temporary utilities that bypass area of demolition and that maintain continuity of service to other parts of building.
 - .3 Cut off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal remaining portion of pipe or conduit after bypassing.
 - .4 Cut off pipe or conduit to a minimum of 1" (25 mm) below slab and remove concrete mound. Patch concrete using cementitious grout.
- .3 Coordinate with mechanical and electrical divisions for shutting off, disconnecting, removing and sealing or capping utilities.
- .4 Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

- .1 Identify and mark equipment and materials identified to be retained by Consultant and/or Owner or to be re-used in subsequent construction. Separate and store items to be retained in an area away from area of demolition and protect from accidental disposal.
- .2 Post warning signs on electrical lines and equipment that must remain energized to serve other areas during period of demolition.
- .3 Confirm that electrical and telephone service lines entering buildings are not disconnected.
- .4 Do not disrupt active or energized utilities crossing the demolition site.
- .5 Provide and maintain barricades, warning signs, protection for workmen and the public during the full extent of the Work. Read Drawings carefully to ascertain extent of protection required.
- .6 Mark materials required to be re used, store in a safe place until ready for re installation.
- .7 Adjust junction boxes, receptacles and switch boxes flush with new wall construction where additional layers to existing construction are indicated.
- .8 Remove permanent marker lines used or found on exposed surfaces and at surfaces indicated for subsequent finish materials. Mechanically remove permanent marker lines and associated substrates where permanent marker lines occur and patch surface. Sealing or priming over permanent marker lines is not acceptable.

3.4 CONCRETE SLAB REINFORCING

- .1 Locate location of reinforcing steel in concrete slabs prior to cutting or coring using non-destructive, non-ionizing radio frequency locators.
- .2 Core concrete slabs to avoid reinforcing steel, electrical conduit or water pipes; adjust core location and coordinate with engineer where slab features interfere with core drilling.

- .3 Notify the engineer immediately for further instructions where coring or cutting will damage existing slab features.

3.5 **SELECTIVE DEMOLITION**

- .1 Demolish and dismantle work in a neat and orderly manner and in strict accordance with regulations.
- .2 At end of each day's work, leave Work in safe condition so that no part is in danger of toppling or falling.
- .3 Demolish in a manner to minimize dusting and to prevent migration of dust.
- .4 Selling or burning of materials on the Project site is not permitted.
- .5 Remove concrete bases by cutting and chipping, take precautions against slab cracking and degradation. Grind edges smooth, fill and make level with self levelling grout.
- .6 Fill openings in concrete block walls with concrete masonry units, coursing to match existing, prepare ready to receive new finishes to match existing.
 - .1 Provide bond beams in new openings cut into existing CMU walls.
 - .2 Provide finished end masonry units to patch and repair for new jamb sections in existing concrete masonry unit walls.
- .7 Fill openings in gypsum board walls with GWB and steel framing to match existing, skim coat to make wall smooth and even.
- .8 Demolish existing carpet, resilient flooring and adhesive remnants as follows:
 - .1 Vacuum existing carpet thoroughly, prior to removal, using vacuum equipped with power head/sweeper.
 - .2 Apply fine mist water spray to carpet as required to minimize dust generation during removal. Avoid spraying near electrical outlets.
 - .3 Demolish existing carpet and resilient floor finishes, remove and dispose of offsite.
 - .4 Remove adhesive to greatest extent possible using scrapping tools and as follows:
 - .1 Do not use solvent-based cleaners to remove adhesive remnants.
 - .2 Lightly shot blast or grind floor using machine designed for purpose to remove adhesive remnants.
 - .3 Vacuum floor ready for application of skim coating.
 - .4 Repair slab depressions and damage with cementitious patching compound.
 - .5 Skim coat floor with minimum 1 mm thick cementitious floor underlayment compatible with new flooring materials.
 - .5 Floor substrate shall be smooth, free from ridges and depressions and adhesive remnants that could telegraph through resilient flooring materials and carpets.
 - .6 Recycle materials in accordance with Section 01 74 00 - Cleaning and Waste Management.

- .9 Demolish existing ceramic tile finishes. Remove setting bed or adhesive to the greatest extent possible using mechanical scrapping tools and as follows:
 - .1 Saw cut edge of tile for clean and even transition joint between existing tile to remain and new flooring materials.
 - .2 Lightly shot blast or grind floor to remove remnants of setting materials.
 - .3 Vacuum floor ready for application of skim coating
 - .4 Repair slab depressions and damage with cementitious patching compound. Skim coat floor with minimum 1 mm thick cementitious floor underlayment compatible with new flooring materials
- .10 Demolish completely ceiling panels and grid as indicated.
- .11 Remove wall coverings scheduled for demolition. Patch and repair wall surfaces with skim coat of gypsum board joint compound leaving wall surfaces smooth and even ready for new wall finishes.
- .12 Patch and repair walls, floor and ceilings damaged during demolition with material matching adjacent walls, prepare ready for new finishes.
- .13 Patch and repair radiation cabinets, mechanical equipment and electrical fixtures damaged or exposed during demolition to match adjacent finished surfaces.

3.6 **PATCHING AND REPAIRING**

- .1 Floors and Walls:
 - .1 Where walls or partitions that are demolished extend from one (1) finished area into another, patch and repair floor and wall surfaces in the new space.
 - .2 Provide a level and smooth surface having 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 Patch with durable seams that are as invisible as possible.
 - .5 Provide materials and comply with installation requirements specified in other Sections of these Specifications.
 - .6 Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
 - .7 Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
- .2 Ceilings: patch, repair or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.7 **PROTECTION**

- .1 Prevent debris from blocking drainage inlets and systems and ground draining and protect material and electrical systems and services that must remain in operation.
- .2 Arrange demolition and shoring work so that interference with the use of adjoining areas by the Owner and users is minimized.
- .3 Maintain safe access to and egress from occupied areas adjoining.

- .4 Provide and maintain fire prevention equipment and alarms accessible during demolition.

3.8 **CLEANING**

- .1 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .2 Waste Management: Separate waste materials for reuse and recycling in accordance with Section 01 74 00 - Cleaning and Waste Management and as follows:
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
- .3 Divert excess materials from landfill to site approved Consultant.
- .4 Promptly as the Work progresses and on completion, clean up and remove from the Project site, rubbish and surplus material. Remove rubbish resulting from demolition work daily.
- .5 Maintain access to exits clean and free of obstruction during removal of debris.
- .6 Keep surrounding and adjoining roads, lanes, sidewalks, municipal rights of way clean and free of dirt, soil or debris that may be a hazard to vehicles or persons.
- .7 Transport material designated for alternate disposal using approved facilities and/or receiving organizations listed in CWM Plan and in accordance with applicable regulations. Written authorization from Consultant is required to deviate from facilities or receiving organizations listed in CWM Plan.
- .8 Dispose of materials not designated for alternate disposal in accordance with applicable regulations.
 - .1 Disposal facilities must be those approved of and listed in CWM Plan.
 - .2 Written authorization from Consultant is required to deviate from disposal facilities listed in CWM Plan.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Liquid applied cementitious self-leveling floor underlayment.

1.2 **SUBMITTALS FOR REVIEW**

- .1 Section 01 33 00 - Submittal Procedures: Submission procedures.
- .2 Product Data: Provide physical characteristics and product limitations.

1.3 **SUBMITTALS FOR INFORMATION**

- .1 Section 01 33 00 - Submittal Procedures: Submission procedures.
- .2 Manufacturer's Instructions: Indicate mix instructions.
- .3 Certificate: Certify that Products meet or exceed specified requirements.

1.4 **CLOSEOUT SUBMITTALS**

- .1 Section 01 78 00 - Closeout Submittals: Submission procedures.

1.5 **QUALITY ASSURANCE**

- .1 Products of this Section: Manufactured to ISO 14000 certification requirements.
- .2 Applicator Qualifications:
 - .1 Company specializing in performing the Work of this Section with minimum five (5) years documented experience and approved by the manufacturer.
 - .2 Installation of the Product specified herein, must be completed by a factory-trained applicator or Install Substrate Prep Certified Installer, using mixing equipment and tools approved by the manufacturer. Contact the manufacturer for a list of recommended installers.

1.6 **REGULATORY REQUIREMENTS**

- .1 Conform to applicable code for combustibility or flame spread requirements.
- .2 Conform to applicable ULC assembly design.

1.7 **MOCK-UP**

- .1 Section 01 40 00 - Quality Requirements: Requirements for mock-up.
- .2 Construct a mock-up of underlayment material.
- .3 Location and size of mock-up as directed by Consultant.
- .4 Approved mock-up may remain as part of the Work.

1.8 **ENVIRONMENTAL REQUIREMENTS**

- .1 Section 01 35 00 - Special Procedures: Environmental conditions affecting Products on Site.
- .2 Do not install underlayment until floor penetrations and peripheral work are complete.

- .3 Do not install material below 10°C surface and air temperatures. These temperatures must also be maintained during and for forty-eight (48) hours after the installation of Products included in this Section. Install quickly if substrate is warm and follow warm weather instructions available from the underlayment manufacturer's technical service department.
- .4 During the curing process, ventilate spaces to remove excess moisture.

1.9 **WARRANTY**

- .1 Self-leveling underlayment installed as part of a floor system, shall be installed in conjunction with the recommended materials by the underlayment manufacturer, to provide a ten (10) year comprehensive warranty.

Part 2 **Products**

2.1 **MANUFACTURERS**

- .1 Basis-of-Design Product: "Novoplan 2 Plus", as manufactured by Mapei Inc. <https://www.mapei.com/ca/en-ca/home>.
- .2 Acceptable Alternate Manufacturers: Subject to compliance with requirements specified herein, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 Ardex <https://www.ardexamericas.com>.
 - .2 Laticrete International Inc. <https://laticrete.com>.
 - .3 Maxxom Canada <http://www.maxxon.ca>.
 - .4 TEC <http://www.tecspecialty.com>.
 - .5 Additional alternates will not be considered. In the event products from unapproved manufacturers are accepted and installed by the Contractor, it will be the responsibility of the Contractor to correct and conform to these Specifications, on schedule and at no extra cost to the Contract or the Owner.

2.2 **CALCIUM-ALUMINATE SELF-LEVELING UNDERLAYMENT**

- .1 Calcium-aluminate-cement-based self-leveling underlayment and repair mix for leveling and smoothing interior concrete floors.
- .2 Product: Subject to compliance with requirements, provide MAPEI Inc.; Novoplan 2 Plus.
- .3 Product Performance:
 - .1 Compressive Strength to ASTM C-109:
 - .1 At seven (7) days > 2,700 psi (18.6 MPa).
 - .2 At twenty-eight (28) days >4,200 psi (29 MPa).
 - .2 Flexural Strength to ASTM C 348 at twenty-eight (28) days >1050 psi (7.24 MPa).

2.3 **MIXES**

- .1 General:
 - .1 Mix Products, in clean containers, according to manufacturer's written instructions.
 - .2 Do not add water, thinners, or additives unless recommended by manufacturer.

- .3 When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
- .2 Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting Work.
- .2 Properly prepared concrete at least twenty-eight (28) days old, stable, sound, dry and free of hydrostatic pressure.
- .3 Ensure that substrate hydrostatic pressure conditions and vapor transmission do not exceed 5 lbs. per 1,000 sq. ft. (2.27 kg per 92.9m²) per twenty-four (24) hours. Use calcium chloride test (reference ASTM F1869) before application. Consult the floor-covering or coating manufacturer's recommendations regarding the maximum allowable MVER and retained moisture content in substrate.
- .4 Ensure that concrete substrate and ambient room temperatures are between 10°C and 29°C before application. Temperatures must be maintained within this range for at least five (5) days after installation of underlayment.
- .5 If substrate preparation is the responsibility of another installer, notify the Consultant of unsatisfactory preparation before proceeding.

3.2 **PREPARATION**

- .1 Substrates must be properly prepared, primed, structurally sound, stable, solid and dry.
- .2 Mechanically profile and prepare concrete surfaces by approved methods in accordance with the most current ICRI 310.2R guidelines to concrete surface profile (CSP) #3.
- .3 Always prime the prepared surface with a MAPEI primer before the application of the underlayment.
- .4 On concrete substrates, fill deep areas, holes and cracks with appropriate patching compound or screed, fluid self-leveler may leak through a floor below or other unwanted cavities.

3.3 **MIXING**

- .1 Choose appropriate safety equipment before use. Refer to the safety data sheet for information.
- .2 Into a clean mixing container, pour the required amount of cool, clean potable water. If available water is not cool, chill the water to 21°C. The mixing ratio is 5 to 5.28 U.S. qts. (4.73 to 5 L) of clean, potable water per 50 lbs. (22.7 kg) bag of mix.
- .3 Add next mix powder while slowly mixing. For best results, maintain a consistent water to powder ratio from mix to mix and do not overwater the material.

- .4 Barrel Mixing:
 - .1 Using the appropriate mixing ratio, mix using a high-speed mixer (at about 1,100 rpm) with an “eggbeater” mixing paddle to a homogenous, lump-free consistency for about two (2) minutes.
 - .2 Do not overmix. Overmixing and moving the paddle up and down during the mixing process could trap air, shorten the pot life or cause pin-holing during the application and curing process.
- .5 Pump mixing:
 - .1 Use a continuous mixer and pump and at least 140’-0” (42.7 m) of hose or a batch mixer and pump and at least 110’-0” (33.5 m) of hose. The mixer and pump must be in good working condition. Periodic cleaning of pumping equipment is required per manufacturer’s instructions. Be sure to pressure-test the rotor and stator before mixing.
 - .2 Use a mesh screen “sock” at the end of the hose to catch any foreign material that could enter the hopper of the mixer.
 - .3 To ensure a suitable mix and flow, test the mixed material from the pump hose’s end in a small area before general application.

3.4 **INSTALLATION**

- .1 Read installation instructions thoroughly before installation.
- .2 Before, during and twenty-four (24) hours after installation, close doors and windows and turn off HVAC systems to prevent drafts. Protect areas from direct sunlight.
- .3 Set the width of the pour at a distance that is ideal for maintaining a flowable wet edge throughout placement. Quickly pour or pump underlayment onto the properly prepared and primed surface in a ribbon pattern. If a flowable wet edge cannot be maintained, reduce the width of the pour. For best results, work as a team to provide a continuous flow of wet material to avoid trapping air or creating a cold joint. Apply enough material to adequately cover all high spots.
- .4 Underlayment has an approximate flow time of ten to fifteen (10 to 15) minutes at 23°C and can be applied from 1/8” to 1” (3 mm to 2.5 cm) in a single application. Apply enough material to adequately cover all high spots. Temperature and humidity will affect working time, flowability and setting time.
- .5 Immediately after placing underlayment, spread the material with a gauge rake. After achieving the desired depth, use a smoother to obtain an even surface. To avoid air entrapment, do not overwork the material.
- .6 For Deeper Fills: 1” to 4” (2.5 to 10 cm), pre-place clean, non-reactive aggregate or pea gravel measuring 1/8” to 3/8” (3 to 10 mm) in diameter over the primed surface at no more than half of the total pour depth. Use only clean, stable aggregates; do not use limestone or other potentially reactive aggregates for extension. Pour underlayment over the placed aggregate, and rake aggressively to ensure full contact and bond with the substrate. Alternately, up to 30% by weight in aggregate can be added directly to underlayment during mixing. Immediately pour an additional ¼” (6 mm) of underlayment over the raked aggregate to provide a smooth, level surface.

3.5 **CURING AND PROTECTION**

- .1 Underlayment is self-curing; do not use a damp-curing method or curing-and-sealing compounds.

- .2 Protect underlayment from excessive heat and drafts during curing. Turn off forced ventilation and radiant heating systems and protect the installation for up to twenty-four (24) hours after completion.
- .3 Avoid walking on installed surface for at least six (6) hours after installation, depending upon the temperature and humidity conditions.
- .4 Protect from wheeled traffic, including scissor lifts and forklifts for at least seventy-two (72) hours. Protect from dirt and dust from other trades until underlayment is completely cured and the final flooring has been installed.

3.6 APPLICATION TOLERANCE

- .1 Section 01 73 00 - Execution: Tolerances.
- .2 Top Surface: Level to 1/16" in 10'-0".
- .3 Install underlayment to tolerances listed in CSA-A23.1/A23.2.

3.7 FIELD QUALITY CONTROL

- .1 Section 01 40 00 - Quality Requirements: Field inspection and testing.
- .2 Placed Material: Inspecting and testing for conformance to specification requirements.
- .3 Where specified, field sampling of the topping is to be done by taking an entire unopened bag of the product being installed to an independent testing facility to perform compressive strength testing in accordance with ASTM C 109/modified: air-cure only. There are no in situ test procedures for the evaluation of compressive strength.

3.8 PROTECTION OF FINISHED WORK

- .1 Section 01 78 00 - Closeout Submittals: Protecting installed Work.
- .2 Do not permit traffic over unprotected floor underlayment surfaces.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Shop fabricated miscellaneous metal items.

1.2 **DEFINITIONS**

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

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for sections, plates, pipe, tubing, bolts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) safety data sheet (SDS) in accordance with Section 01 35 23 - Health and Safety.
 - .3 For finishes, coatings, primers and paints applied on site: indicate volatile organic compound (VOC) concentration in g/L.
- .3 Shop Drawings:
 - .1 Submit Shop Drawings stamped and signed by professional engineer registered or licensed in province or territory, Canada.
 - .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories.
- .4 Certificates: Submit certifications for Application Specialists to demonstrate compliance to the requirements of ANSI/NACE No.13.

1.4 **QUALITY ASSURANCE**

- .1 Test Reports: Submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certifications: Submit Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Qualifications:
 - .1 Ensure that industrial coating and/or lining applications specialists, who perform concrete and steel surfaces preparation and coating applications, are certified by a recognized applicator certification agency, in accordance with NACE 13 /SSPC ACS-I, Applicator Certification Standard (ACS).
 - .2 Maintain a current and valid ACS certification during project period. Application specialists who perform surface preparation and coating application Work on this Project must have a current ACS.

- .3 Notify Consultant of change(s) in application specialist certification status. Delays to the completion of the Project due to invalid certifications will not be considered and liquidated damages shall not be waived for non-performance by Contractor.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: Deliver materials to the Project site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan and Waste Reduction Workplan related to Work of this Section.

Part 2 Products

2.1 MATERIALS

- .1 Steel sections and plates to CSA G40.20/G40.21, Grade300W 350W.
- .2 Steel pipe to ASTM A53/A53M standard weight galvanized finish.
- .3 Welding materials to CSA W59.
- .4 Welding electrodes to CSA W48 Series
- .5 Bolts and anchor bolts to ASTM A307
- .6 Grout: Non-shrink, non-metallic, flowable, 15 MPa at twenty-four (24) hours.

2.2 FABRICATION

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
- .2 Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated.
- .3 Where possible, fit and shop assemble work, ready for erection.
- .4 Exposed welds continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 FINISHES

- .1 Galvanizing: Hot dipped galvanizing with zinc coating 600 g/m² to CAN/CSA-G164
- .2 Chromium Plating: Chrome on steel with plating sequence of 0.009 mm thickness of copper 0.01 mm thickness of nickel and 0.0025 mm thickness of chromium.
- .3 Shop coat primer in accordance with chemical component limits and restrictions requirements and VOC limits of UL 2768.

- .4 Zinc Primer: Zinc rich, ready mix in accordance with chemical component limits and restrictions requirements and VOC limits of UL 2768.

2.4 ISOLATION COATING

- .1 Isolate aluminum from following components, by means of bituminous paint:
 - .1 Dissimilar metals except stainless steel, zinc or white bronze of small area.
 - .2 Concrete, mortar and masonry.

2.5 SHOP PAINTING

- .1 Primer: VOC limit 250 g/L maximum to UL 2768.
- .2 Apply one (1) shop coat of primer to metal items, with exception of galvanized or concrete encased items.
- .3 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Paint when temperature minimum 7°C.
- .4 Clean surfaces to be field welded; do not paint.

2.6 ANGLE LINTELS

- .1 Steel Angles: Galvanized sizes indicated for openings. Provide 150 mm minimum bearing at ends.
- .2 Weld or bolt back-to-back angles to profiles as indicated.
- .3 Finish and Primer: VOC limit 250 g/L maximum to GS-11 when applied onsite.

Part 3 Execution

3.1 EXAMINATION

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

3.2 ERECTION - GENERAL

- .1 Do welding work in accordance with CSA W59 unless specified otherwise
- .2 Erect metalwork square, plumb, straight and true, accurately fitted, with tight joints and intersections.
- .3 Provide suitable means of anchorage acceptable to Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields and toggles.
- .4 Exposed fastening devices to match finish and be compatible with material through which they pass.

- .5 Supply components for work by other trades in accordance with Shop Drawings and schedule.
- .6 Make field connections with bolts to CSA S16 or Weld field connection.
- .7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.
- .8 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion of: Primer: maximum VOC limit 250 g/L to GS-11.
- .9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.
- .10 Primer: Maximum VOC limit 250 g/L to GS-11.

3.3 **CLEANING**

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

3.4 **PROTECTION**

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

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Compact laminates.
- .2 Decorative edges and edgeband.
- .3 Accessory materials.

1.2 **PRE-INSTALLATION MEETING**

- .1 Before enclosing framing, convene a meeting of Contractor, fabricator, installer, framing Subcontractor and Consultant:
 - .1 Review locations of backing required for installation as shown on Shop Drawings and as necessary for installation.
 - .2 Review method of installation.
 - .3 Review coordination with other affected sections.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Include manufacturer's instructions, printed product literature, data sheets and catalogue pages for materials and Products to be incorporated into Project and include Product characteristics, performance criteria, dimensions and profiles, finish and limitations on use.
 - .2 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) safety data sheets (SDS) in accordance with Section 01 35 23 - Health and Safety.
- .3 Shop Drawings:
 - .1 Submit two (2) sets of Shop Drawings for initial review in accordance with Division 01 – General Requirements. Revise as directed, submit six (6) copies for final acceptance and distribution.
 - .2 Indicate details of construction, profiles, jointing, fastening and related details.
 - .3 Scales: Profiles full size, details half full size.
 - .4 Indicate materials, thicknesses, finishes and hardware.
 - .5 Indicate locations of service outlets in casework, typical and special installation conditions and connections, attachments, anchorage and location of exposed fastenings.
 - .6 Show location on elevations of backing required in supporting structure.
 - .7 Include color schedule of items, including exposed and semi-exposed finishes, finish material manufacturer, pattern and color.
 - .8 Submit Drawings stamped and signed by professional engineer registered or licensed in province where Project is located.
- .4 Samples: Selection and verification samples for each color, pattern and finish required.

1.4 **QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Manufacturer producing products in an ISO 9001, ISO 14001 and OHSAS 18001 certified facility.
- .2 Fabricator Qualifications: Minimum of five (5) years documented experience in fabricating decorative plastic laminates similar in scope and complexity of this Project.
- .3 Installer Qualifications: Minimum of five (5) years documented installation experience for projects similar in scope and complexity to this Project. Installer shall be the fabricator.
- .4 Mock-Ups:
 - .1 Install at Project site using acceptable products and manufacturer approved installation methods. Obtain Consultant's acceptance for color, pattern, finish, fabrication and installation standards.
 - .2 Mock-Up Size: As directed by Consultant.
 - .3 Mock-Up Location: As directed by Consultant.
 - .4 Maintain mock-up during construction for fabrication and installation comparison. If required, remove and legally dispose of mock-up when no longer required.
 - .5 Incorporation: If permitted by Consultant, mock-up may be incorporated into as part of the completed Work.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Storage and Protection: Store plastic laminate materials protected from exposure to harmful weather conditions, at temperature and humidity conditions recommended by manufacturer. Store sheet materials flat on pallets or similar rack-type storage to preclude damage.

Part 2 Products

2.1 **MANUFACTURER**

- .1 Basis of Design: Model "Resin Compact Panel" as manufactured by Wilsonart. <https://www.wilsonart.com>.
- .2 Substitutions: Not permitted.

2.2 **LAMINATE PROPERTIES**

- .1 Laminate Composition: Decorative surface papers impregnated with melamine resins and pressed over kraft paper core sheets impregnated with phenolic resin. Sheets then bonded together under pressures greater than 1,000 lbs/in² and high temperatures approaching 49°C. Finished sheets trimmed and backs sanded to facilitate bonding to substrate.
- .2 Surface Burning Characteristics:
 - .1 Test Standards: ASTM E 84, ASTM E 162, ASTM E 662, IMO FTP Code Part 2 and Part 5 and UL 723.
 - .2 Interior Finish Classification, Fire-Rated Laminate: Class A according to NFPA 101. Flame spread less than 25 and Smoke Developed less than 450.
- .3 Surfaces Subject to Food Contact: Comply with NSF Standard 35.

2.3 **COMPACT LAMINATES**

- .1 Product: "Wilsonart Compact Laminate."
- .2 "Wilsonart Classic Grade":
 - .1 Self-supporting homogenous panels finished with melamine surface. Impact-resistant design.
 - .2 Product Type and Nominal Thickness: As indicated on the Drawings.
 - .3 Laminate Conformance Standard: NEMA LD 3, Grade CGS.
 - .4 Finish: Matte 60.
 - .5 Color and Pattern:
 - .1 Indicated on Drawings.
 - .2 Selected from manufacturer's full range of available selections.
- .3 "Wilsonart Fire-Rated Grade":
 - .1 For applications where fire-rated properties are required. Double-faced. Class A rated according to NFPA 101.
 - .2 Product Type and Nominal Thickness: As indicated on the Drawings.
 - .3 Laminate Conformance Standard: NEMA LD 3, Grade CGS.
 - .4 Finish: Matte 60.
 - .5 Color and Pattern:
 - .1 Indicated on Drawings.
 - .2 Selected from manufacturer's full range of available selections.

2.4 **DECORATIVE EDGES AND EDGEBANDS**

- .1 Decorative Edge Products:
 - .1 "Wilsonart Decorative Edges."
 - .2 Color and Pattern:
 - .1 Indicated on Drawings.
 - .2 Selected from manufacturer's full range of available selections.
- .2 Edgeband Products:
 - .1 "Wilsonart Edgeband."
 - .2 Color and Pattern:
 - .1 Indicated on Drawings.
 - .2 Selected from manufacturer's full range of available selections.

2.5 **ACCESSORY MATERIALS**

- .1 Contact Adhesive:
 - .1 Product: "Wilsonart 1730/1731 Low VOC Contact Adhesive."

- .2 Description: High solids, low volatile organic compound (VOC) contact adhesive for non-postforming applications.
 - .2 Contact Adhesive, Water-Based:
 - .1 Product: "Wilsonart H²O."
 - .2 Description: Non-flammable low VOC water-based contact adhesive for postforming applications.
 - .3 Polyvinyl Acetate (PVA) Adhesive:
 - .1 Product: "Wilsonart PVA Adhesive."
 - .2 Description: PVA-based adhesives for bonding decorative laminate to wood substrates. Acceptable for cold press, hot press and postforming applications.
- Part 3 Execution
- 3.1 **EXAMINATION**
- .1 Examine surfaces for conditions that could adversely affect the performance of the decorative plastic laminate installation, including edge performance.
 - .2 Surfaces to be adhesively bonded shall be clean, dry and free of any dust, loose paint, wax, moisture, dirt, grease, oil, rust or other contaminants.
 - .3 Commencement of work will constitute acceptance of existing conditions and surfaces to receive the work.
- 3.2 **INSTALLATION**
- .1 Install materials according to referenced Sections and the following conformance standards as applicable:
 - .1 AWI AWS.
 - .2 KCMA A161.1.
 - .2 To avoid stress cracking, do not use square-cut inside corners. Inside corners to have a minimum 1/8" radius and edges routed smooth.
 - .3 Drill oversized holes for screws, bolts and similar fasteners. Slightly countersink fasteners into face side of laminate-clad substrate.
 - .4 Use carbide-tipped saw and router blades for cutting, with high tool speed and low feed speed. Keep cutting blades sharp. Use appropriate hold-downs to prevent vibration.
- 3.3 **ADHESIVE SPRAY APPLICATIONS**
- .1 Comply with adhesive manufacturer's printed installation instructions.
 - .2 Apply contact adhesive uniformly to both surfaces and with a minimum 80 % coverage for each surface. Apply PVA adhesive to one (1) side with a minimum 80 % coverage.
 - .3 Apply two (2) coats of adhesive to porous surfaces. Provide 100 % coverage for edges.
 - .4 Apply uniform downward pressure (30 to 40 psi minimum) across the entire bonded surface.

3.4 ADHESIVE BRUSH APPLICATIONS

- .1 Comply with adhesive manufacturer's printed installation instructions.
- .2 Apply contact adhesive uniformly to both surfaces with a brush or solvent-resistant medium nap roller; cover each surface 100 %. Apply PVA adhesive to one (1) side, for 100 % coverage.
- .3 Provide two (2) coats of adhesive on porous surfaces. Double coat edges.
- .4 Apply uniform downward pressure (30 to 40 psi minimum) across the entire bonded surface.

3.5 CLEANING AND PROTECTION

- .1 Clean decorative plastic laminate according to manufacturer's printed care and maintenance instructions.
- .2 Protect installed Products and finish surfaces from damage during remainder of construction period.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Miscellaneous rough carpentry, including but not limited to plywood.
- .2 Fasteners.
- .3 Fire retardant treatment.

1.2 **DEFINITIONS**

- .1 Environmental Product Declaration (EPD):
 - .1 Third-party verified documentation with supporting product category rule (PCR) and life-cycle assessment (LCA) information, including at least a cradle-to-gate scope. Prepared in accordance with ISO 14025, 14040, 14044 and EN 15804 or ISO 21930.
 - .2 Industry-wide (generic) EPD with third-party certification (Type III), including external verification where the manufacturer is explicitly recognized as the participant by the program operator.
 - .3 Product-specific Type III EPD Products with third-party certification (Type III), including external verification where the manufacturer is explicitly recognized as the participant by the program operator.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Action Submittals (to be submitted before starting Work of this Section):
 - .1 Product Data:
 - .1 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.
 - .2 Submit certified test reports for prefabricated structural members from an approved independent laboratory indicating compliance with Specifications for specified performance characteristics and physical properties.
 - .3 Submit manufacturer's installation instructions.
- .3 Informational Submittals (submitted during Work) and Material Certificates: Submit certificates for machine-graded dimensional lumber indicating species and grade selected for each use and design values approved by National Lumber Grades Authority (NLGA).

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Delivery and Acceptance Requirements: Protect materials from weather conditions while in transit and while on the Project site.
- .2 Storage and Handling Requirements:
 - .1 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.
 - .2 Protect edges and corners of sheet materials from damage during handling and storage.

- .3 Protect kiln-dried and seasoned wood materials from conditions that will cause an increase to moisture content.
- .4 Store engineered lumber on its edge.
- .5 Stack, lift, brace, cut and notch engineered lumber Products in accordance with manufacturer's instructions and recommendations.
- .6 Store separated reusable wood waste convenient to cutting station and work areas.
- .3 Packaging Waste Management: Perform In accordance with Section 01 74 00 - Cleaning and Waste Management.

Part 2 Products

2.1 DESCRIPTION

- .1 Regulatory Requirements:
 - .1 Lumber Grades:
 - .1 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 that conform to National Grading Rules published by the NLGA.
 - .2 Grading: Machine Grading, Visual Grading or Both.
 - .3 Moisture Content: Kiln Dry 15% or less.
 - .4 Structural Design Properties: Strength and related properties in accordance with CSA O86.
 - .5 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.
- .2 Sustainability Characteristics:
 - .1 Environmental Product Declaration (EPD): Submit an Industry-wide EPD or Product specific EPD for each lumber specified. Provide EPD with at least a cradle to gate scope, identifying the following impact categories:
 - .1 Global Warming Potential (GWP): GWP information submitted in the form of kgCO₂ eq/kg.
 - .2 Ozone Depletion Potential (ODP): ODP information submitted in the form of kgCFC-11/kg.
 - .3 Acidification Potential (AP): AP information submitted in the form of kgSO₂ /kg.
 - .4 Eutrophication Potential (EP): EP information submitted in the form of kg N/kg.
 - .5 Photochemical Ozone Creation/Smog Formation Potential (SFP): SFP information submitted in the form of kgO₃ /kg.

- .2 Certified Wood Sourcing: Wood products (dimensional lumber, plywood and similar materials) used for the Project must be extracted and sourced from US Green Building Council (USGBC) recognized sustainable forestry certification agencies and that can demonstrate compliance in legal extraction, responsible sourcing and proof of chain of custody from one (1) of the following agencies:
 - .1 American Tree Farm System (ATFS).
 - .2 CSA Group (CSA).
 - .3 Forest Stewardship Council (FSC).
 - .4 Programme for the Endorsement of Forest Certification (PEFC).
 - .5 Sustainable Forestry Initiative (SFI).
- .3 Alternative to Certified Sourcing Requirements: Consultant will consider the use of an Alternate Compliance Path (ACP) based on certification requirements described in ASTM D7612, using defined third party certified sourcing categories as follows:
 - .1 Legally Compliant (Non-controversial) Sources.
 - .2 Responsible Sources.
 - .3 Certified Sources (Chain of Custody).
- .4 Material Toxicity - Low Emitting Materials: Materials must demonstrate volatile organic compound (VOC) emissions equal to or less than maximum permitted for materials described herein, meeting formaldehyde emissions for composite wood products for ultra-low emitting formaldehyde or no added formaldehyde in accordance with California Air Resources Board Airborne Toxic Control Measures (ATCM).

2.2 PERFORMANCE CRITERIA

- .1 Plywood Grades: Provide plywood products in nominal dimensions required for the Project, grade-marked by accredited agencies of the APA and that conform to the Canadian Plywood Grading Guide and tolerances described for specific plywood Products below and identified as follows:
 - .1 Name of Standard CSA O121 or CSA O151.
 - .2 Manufacturer's Mill Identification.
 - .3 Bond Quality (Exterior or Interior).
 - .4 Commercial Species Grouping (DFP, CSP, ASP or HEM-FIR).
 - .5 Product Grade (SHG, SEL, SEL TF, G1S or G2S).
 - .6 Nominal Thickness and
 - .7 Additional Grade or Product Designations (if applicable).

2.3 MATERIALS

- .1 Panel Materials:
 - .1 Provide plywood wall sheathing required by span rating and meeting requirements of CSA O325 and as follows:
 - .1 Interior rated, sheathing grade square edged Douglas Fir or Canadian Softwood Plywood meeting requirements of CSA O121 or O151.

.2 Fire-Retardant Treated Wood (FRTW):

- .1 Use only wood treatments meeting requirements of CAN/CSA-O80 Series and that are tested in accordance with CAN/ULC-S102 or CAN/ULC-S102.2 for flame spread and smoke developed classifications. Ensure treated wood Products clearly indicate on the face or edge the following labelling requirements in accordance with Wood Preservation Canada:
- i. ULC Label describing flame spread and smoke developed performance ratings.
 - ii. Name of registered treatment.
 - iii. Basic safety instructions.
 - iv. Consumer safety contact information; and
 - v. Grading marks required by wood products described herein.

2.4 **ACCESSORIES**

.1 Driven Fasteners:

- .1 Steel nails, spikes, brads and staples meeting requirements of ASTM F1667. Ensure length is sufficient to penetrate connecting solid wood materials.
- .2 Interior High Humidity Work: Hot-dipped galvanized.
- .3 Interior Work: Electroplated zinc plated or cadmium plated.
- .4 FRTW as specified herein.

.2 Rough Hardware (Bolts, Nuts and Washers): Provide manufacturer recommended fastening devices and anchors meeting requirements of ASTM A307 and as follows:

- .1 Ground Contact Materials: Stainless steel.
- .2 Interior High Humidity Work: Hot-dipped galvanized.
- .3 Interior Work: Electroplated zinc plated or cadmium plated.
- .4 FRTW as specified herein.

.3 Wood Screws: Steel screws meeting requirements of ASME B18.6.1 and as follows: Interior Work: Galvanized.

.4 Screws for Fastening to Cold-Formed Metal Framing: Steel screws meeting requirements of ASTM C954, except for wafer heads and reamer wings whose length should be as recommended by screw manufacturer for material being fastened.

.5 General Purpose Adhesive: CSA O112.9.

Part 3 Execution

3.1 **EXAMINATION**

.1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.

.2 Verification of Conditions:

- .1 Verify conditions of substrates previously installed are acceptable for Product installation in accordance with manufacturer's instructions.
- .2 Visually inspect substrate in presence of Consultant.

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

3.2 **INSTALLATION**

- .1 Requirements:
 - .1 Accurately frame and properly assemble rough carpentry work.
 - .2 Securely attach rough carpentry work to substrate by anchoring and fastening.
 - .3 Include required nails, fastenings and other connectors.
 - .4 Set rough carpentry to required levels and lines with members plumb, true to line, cut and fitted.
 - .5 Fit rough carpentry to other construction.
 - .6 Scribe and cope as needed for accurate fit.
 - .7 Locate furring, nailers, blocking, grounds and similar supports as required when attaching to other construction.
 - .8 Do not use materials with defects that impair the quality of the rough carpentry or use pieces that are too small to use with a minimum number of joints or optimum joint arrangement.
- .2 FRTW Installation: Install plywood as indicated on the Drawings.

3.3 **CLEANING**

- .1 Progress Cleaning: Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .2 Final Cleaning: Upon completion, remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.

3.4 **PROTECTION**

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

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Custom, (shop) fabricated architectural woodwork.

1.2 **PRE-INSTALLATION MEETING**

- .1 Before enclosing framing, convene a meeting of Contractor, casework fabricator, casework installer, framing subcontractor and Consultant:
 - .1 Review locations of backing required for casework installation as shown on Shop Drawings and as necessary for installation.
 - .2 Review method of attachment for backing to wall system.
 - .3 Review coordination with other affected sections.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Prepare and submit material list in accordance with Architectural Woodwork Manufacturers Association of Canada (AWMAC) North American Architectural Woodwork Standards (NAAWS), cross-referenced to Specifications.
 - .2 Include manufacturer's instructions, printed product literature, data sheets and catalogue pages for materials and Products to be incorporated into architectural wood casework and include Product characteristics, performance criteria, dimensions and profiles, finish and limitations on use.
 - .3 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS) in **accordance** with Section 01 35 23 - Health and Safety.
- .3 Hardware List:
 - .1 Submit hardware list cross-referenced to Specifications.
 - .2 Include manufacturer's specification sheets indicating name, model, material, function, finish, Builders Hardware Manufacturers Association (BHMA) designations and other pertinent information.
- .4 Shop Drawings:
 - .1 Prepare and submit Shop Drawings in accordance with AWMAC.
 - .2 Submit two (2) sets of Shop Drawings for initial review in accordance with Division 01 – General Requirements. Revise as directed, submit six (6) copies for final acceptance and distribution.
 - .3 Indicate details of construction, profiles, jointing, fastening and other related details.
 - .4 Scales: Profiles full size, details half full size.
 - .5 Indicate materials, thicknesses, finishes and hardware.
 - .6 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.

- .7 Show location on casework elevations of backing required in supporting structure for attachment of casework.
- .8 Indicate AWMAC AWS quality grade where different from predominant grade specified.
- .9 Include color schedule of all casework items, including countertop, exposed, and semi-exposed cabinet finishes, finish material manufacturer, pattern, and color.
- .5 Samples:
 - .1 Prepare and submit samples in accordance with AWMAC AWS and as follows: Apply sample finishes to specified substrate or core material minimum 1'-0" x 1'-0" (300 x 300 mm) to match sample. For veneers with transparent finish submit three (3) samples to illustrate range and colour of grain expected.
 - .2 Shop Applied Coatings:
 - .1 For transparent finish, submit triplicate samples of each species and cut of wood to be used, finished to match Project sample.
 - .2 For opaque finish, submit triplicate samples for each colour selection, finished to match Project sample.
 - .3 Submit duplicate samples of laminated plastic for each specified colour selection.
 - .4 Submit duplicate samples of laminated plastic joints, edging, cut-outs and post-formed profiles.
 - .5 Furnish four (4) samples of each lumber and composite panel material to Contractor for preparation of site applied finish samples in accordance with Section 09 91 23 - Interior Painting.
 - .6 Certifications: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .7 Submit statement of experience and qualifications of architectural wood casework fabricator.

1.4 **SUSTAINABLE DESIGN SUBMITTALS**

- .1 Submit vendor's and/or manufacturer's Chain-of-Custody Certificate number for CAN/CSA-Z809 or Forest Stewardship Council (FSC) or Sustainable Forestry Initiative (SFI) certified wood.
- .2 Submit vendor's and/or manufacturer's FSC Chain-of-Custody Certificate number.
- .3 Submit ASTM E1333 test report for formaldehyde emissions from composite wood Products showing compliance with specified limits.
- .4 Submit Product data indicating compliance with other specified sustainable design characteristics.

1.5 **QUALITY ASSURANCE**

- .1 Perform Work of this section by single architectural wood casework fabricator with minimum five (5) years of current architectural casework production experience and having completed minimum one (1) project in the past five (5) years with value within 20% of the cost of the Work of this section.

- .2 Independent inspection/testing agency will be engaged by Owner for purpose of inspecting and/or testing Work of this section. Cost of inspection and testing services will be borne by the Owner.
- .3 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 40 00 - Quality Requirements.
 - .2 Shop prepare one (1) base cabinet unit, wall cabinet, counter top and shelving unit, complete with hardware and shop applied finishes, and install where directed by the Consultant
 - .3 Allow twenty-four (24) hours for inspection of mock-up by Consultant before proceeding with Work.
 - .4 When accepted, mock-up will demonstrate minimum standard for Work.
 - .5 Do not proceed with Work before receipt of written acceptance of mock-up by Consultant.
 - .6 Accepted mock-up may not remain as part of finished Work.

1.6 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 Deliver wood casework only when area of work is enclosed, plaster and concrete work is dry, and area is broom clean and site environmental conditions are acceptable for installation.
- .3 Protect millwork against dampness and damage during and after delivery.
- .4 Store millwork in ventilated areas, protected from extreme changes of temperature and humidity, and within range recommended by AWMAC AWS for location of Project.
- .5 Store materials indoors, in dry location, in clean, dry and well-ventilated area.
- .6 Protect architectural woodwork and hardware from nicks, scratches, and blemishes.
- .7 Replace defective or damaged materials with new.

Part 2 Products

2.1 SUSTAINABILITY CHARACTERISTICS

- .1 Lumber, plywood and composite wood Products to be CAN/CSA-Z809 or FSC or SFI certified.
- .2 Composite Wood Products:
 - .1 Contain no added formaldehyde.
 - .2 Hardwood Plywood with Veneer Core (HWPW-VC): 0.05 ppm.
 - .3 Hardwood Plywood with Composite Core (HWPW-CC): 0.05 ppm.
 - .4 Particleboard (PB): 0.09 ppm.
 - .5 Medium Density Fibreboard (MDF): 0.11 ppm.
 - .6 Thin (less than 8 mm) MDF: 0.13 ppm.

- .3 Recycled Content: Fibreboard must contain less than 10% roundwood by weight, using weighted average over three (3) month period at manufacturing locations.
- .4 Adhesives: VOC limit 30 g/L maximum to South Coast Air Quality Management District (SCAQMD) Rule 1168 GS-36.
- .5 Coatings:
 - .1 Clear Wood Finishes: VOC limit 350 g/L maximum to GS-11 SCAQMD Rule 1113.
 - .2 Paints: VOC limit 50 g/L maximum to GS-11 SCAQMD Rule 1113.

2.2 **QUALITY GRADE**

- .1 Provide materials and perform fabrication in accordance with AWMAC AWS Custom Grade.
- .2 In case of conflict between Contract Documents and AWMAC AWS grade requirements, Contract Documents govern.

2.3 **LUMBER**

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

2.4 **PANEL MATERIALS**

- .1 Interior mat-formed wood particleboard to ANSI/NPA A208.1, industrial grade M-2 or M-3, medium density (640-800 kg/m³), thickness ¾" (19 mm) unless indicated otherwise.
 - .1 Use moisture resistant grade 2-M-2 or 2-M-3 for countertops and splash backs to receive plumbing fixtures.
- .2 Medium density fibreboard (MDF) core to ANSI A208.2, density 769 kg/m³, 19 mm thick unless indicated otherwise.
- .3 Use moisture resistant MR grade for countertops and splash backs to receive plumbing fixtures.
- .4 Douglas fir plywood (DFP) to CSA O121, standard construction
- .5 Hardwood plywood to ANSI/HPVA HP-1.
- .6 Canadian softwood plywood (CSP) to CSA O151, standard construction
- .7 Poplar plywood (PP) to CSA O153, standard construction
- .8 Hardboard to CAN/CGSB-11.3

2.5 **DECORATIVE OVERLAID COMPOSITE PANELS**

- .1 Thermally Fused Laminate (TFL):
 - .1 To NEMA LD3 Grade VGL, High wear resistant thermofused Melamine: Equal or exceed four hundred (400) cycles (Minimum standard for HPL abrasion test).

- .2 Laminate: Decorated paper with melamine or polyester resin, from based on printed pattern multilayered colour range with finish selected by Consultant from manufacturer's full range.
- .3 Core as indicated on the Drawings.
- .2 Overlay bonded to both faces where exposed two (2) sides, and when panel material require surface on one (1) side only, reverse side to be overlaid with a plain (buff) balancing sheet.

2.6 LAMINATED PLASTIC MATERIALS

- .1 Laminated plastic for flatwork to NEMA LD3:
 - .1 High pressure decorative laminated (HPDL) plastic:
 - .1 Type: GP (general purpose).
 - .2 Horizontal Surfaces: HGS or HGL to suit application, 1.2 mm thick.
 - .3 Vertical Surfaces: VDS or VGL to suit application, 0.71 mm thick.
 - .4 Colour: Multilayered.
 - .5 Pattern: As indicated on the Drawings.
 - .6 Finish: As indicated on the Drawings.
 - .2 Laminated Plastic for Backing Sheet:
 - .1 Type: Backer.
 - .2 Grade: As indicated on Drawings or as per requirements of the Project.
 - .3 Thickness: Not less than 0.5 mm thick or same thickness as face laminate.
 - .4 Colour: same colour as face laminate unless otherwise indicated on the Drawings.
 - .3 Thermofused Melamine to NEMA LD3 Grade LPDL: High wear resistant thermofused melamine, equal or exceed four hundred (400) cycles (Minimum standard for HPL abrasion test).
 - .4 Edge finishing for doors, drawer fronts, shelves and false fronts:
 - .1 HPDL to match face.
 - .2 PVC or ABS: solid colour to match face with thickness as indicated on the Drawings.
 - .3 Matching melamine and polyester overlay edge strip with thermoplastic adhesive.
 - .4 Edges dadoed or saw kerfed to take plastic "T" moulding in width and colour to match face.

2.7 CASEWORK FABRICATION - GENERAL

- .1 Fabricate casework of specified core and surface finish materials to specified AWMAC AWS quality grade:
 - .1 Construction Type: Face frame.

- .2 Door-cabinet interface as indicated on the Drawings.
- .2 Set Nails and Countersink Screws: Apply stained and/or plain wood filler to indentations, sand smooth and leave ready to receive finish.
- .3 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.
- .4 Shelving to cabinetwork to be adjustable unless otherwise noted.
- .5 Provide cut-outs for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.
- .6 Shop assemble work for delivery to Project site in size easily handled and to ensure passage through building openings.
- .7 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.

2.8 LAMINATED PLASTIC CASEWORK FABRICATION

- .1 Do laminated plastic fabrication in compliance with NEMA LD3, Annex A and specified AWMAC AWS quality grade
- .2 Ensure adjacent parts of continuous laminate work match in colour and pattern.
- .3 Veneer laminated plastic to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 10'-0" (3000 mm). Keep joints 2'-0" (600 mm) from sink cut-outs.
- .4 Use self-edging laminate strip for flatwork to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20°. Do not mitre laminate edges.
- .5 Apply laminate backing sheet to reverse side of core of plastic laminate work.
- .6 Apply laminated plastic liner sheet to interior of cabinetry.
- .7 Drawer Construction:
 - .1 Sides:
 - .1 Custom grade: LPDL (melamine) or HPDL on particleboard MDF, thickness 16 mm.
 - .2 Premium Grade: 7-ply veneer core with HPDL faces.
 - .2 Bottoms: Hardwood plywood of same species as drawer sides, thickness 6 mm.
 - .3 Joinery:
 - .1 Meeting requirements of AWMAC for Grade specified.
 - .2 Sides, Front and Back: Dowel screwed.
 - .4 Drawer bottoms held in place with drawer hardware to sides and mechanically fastened to back and sub front.

2.9 WOOD CASEWORK FABRICATION

- .1 Fabricate casework bodies of specified veneered plywood panel materials in accordance with AWMAC AWS requirements for grade specified and as follows:
 - .1 Exposed Interior Surfaces: Veneer of same species and cut and grade as exposed exterior surfaces.

- .2 Semi-Exposed Surfaces: Veneer of same species as exposed exterior surfaces.
- .2 Fabricate door, drawer and panel surfaces of specified veneered plywood panel materials of specified veneers laid up as specified.
- .3 Drawer Construction:
 - .1 Sides:
 - .1 AWMAC AWS Custom grade: solid wood of manufacturer's species option LPDL melamine surface.
 - .2 AWMAC AWS Premium Grade: Prefinished seven (7) ply hardwood veneer core with no internal voids 16 mm thickness unless indicated otherwise on the Drawings.
 - .2 Bottoms: Hardwood plywood of same species as drawer sides, 6 mm thick.
 - .3 Joinery:
 - .1 Meeting requirements of AWMAC AWS for Grade specified.
 - .2 Sides, Front and Back: Dowel screwed.
 - .3 Drawer bottoms held in place with drawer hardware to sides and mechanically fastened to back and sub front.

2.10 **SHOP APPLIED FINISH COATINGS**

- .1 Finish System:
 - .1 As indicated on the Drawings.
 - .2 Include filler, wash coat and stain.
- .2 Apply finish system component materials in accordance with manufacturer's instructions.
- .3 For raw wood (pulls, trims, molding and edge banding) on HPDL casework, provide AWMAC AWS finish system.

2.11 **CABINET HARDWARE**

- .1 Cabinet Hardware: To AWMAC AWS quality grade specified and to ANSI/BHMA A156.9, designated by letter B and numeral identifiers as listed below
- .2 Finish:
 - .1 Exposed hardware as indicated on the Drawings.
 - .2 Semi-exposed hardware as indicated on the Drawings.
- .3 Casework Door Hinges: As indicated on the Drawings.
- .4 Other Hinges: As indicated on the Drawings.
- .5 Pulls: As indicated on the Drawings.
- .6 Knobs: As indicated on the Drawings.
- .7 Latches: As indicated on the Drawings.
- .8 Catches: As indicated on the Drawings.
- .9 Shelf Rests and Standards: As indicated on the Drawings.
- .10 Shelf Brackets and Standards: As indicated on the Drawings.

- .11 Drawer Slides:
 - .1 Slide Type: As indicated on the Drawings.
 - .2 Extension and Capacity: As indicated on the Drawings.
 - .3 File Drawer Slides: Full extension.
- .12 Pull Up Shelf Supports: As indicated on the Drawings.
- .13 Track and Guides for Sliding Panels: Surface or recessed mounted with anti-friction inserts, type as indicated on the Drawings.
- 2.12 **CABINET LOCKS**
 - .1 Provide locks as shown on elevations at cabinet doors and drawers.
 - .2 Cabinet Locks: To ANSI/BHMA A156.11, designated by letter E and numeral identifiers as listed:
 - .1 Door or Drawer Locks: As indicated on the Drawings.
 - .2 Sliding Door Locks: As indicated on the Drawings.
 - .3 Elbow catches at double doors with locks.
 - .3 Keying:
 - .1 As indicated on the Drawings.
 - .2 Provide keys per lock in quantities requested by the Owner.
 - .3 Provide master keys in quantities requested by the Owner.
 - .4 Stamp keying code numbers on keys and cylinders.
 - .4 Finished as indicated on the Drawings.
- 2.13 **ACCESSORIES**
 - .1 Wood Screws: Type and size to suit application and as indicated on the Drawings.
 - .2 Nails and staples to CSA B111 and ASTM F1667
 - .3 Splines: As indicated on the Drawings.
 - .4 Sealant in accordance with Section 07 92 00 - Joint Sealants.
- 2.14 **LAMINATED PLASTIC COUNTERTOPS**
 - .1 Laminated plastic for flatwork to NEMA LD3:
 - .1 Type: General purpose.
 - .2 Grade: HGS or HGL.
 - .3 Size: 1.2 mm thick unless otherwise indicated on the Drawings.
 - .4 Colour: As indicated on the Drawings.
 - .5 Pattern: As indicated on the Drawings.
 - .6 Finish: As indicated on the Drawings.

- .2 Core Material:
 - .1 As indicated on the Drawings.
 - .2 Countertops to Receive Plumbing Fixtures: Water resistant and as indicated on the Drawings.
- .3 Back Splashes: Per Drawings.
- .4 Front Edges: As indicated on the Drawings.

Part 3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install architectural wood casework in accordance with AWMAC AWS grade for respective items
- .2 In case of conflict between Contract Documents and AWMAC AWS grade requirements, Contract Documents govern.
- .3 Install prefinished millwork at locations shown on Drawings. Position accurately, level, plumb straight.
- .4 Fasten and anchor millwork securely. Supply and install heavy duty fixture attachments for wall mounted cabinets.
- .5 Countersink mechanical fasteners at exposed and semi-exposed surfaces, excluding installation attachment screws and screws securing cabinets end to end.
- .6 Use draw bolts in countertop joints.
- .7 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.
- .8 At junction of plastic laminate counter back splash and adjacent wall finish, apply small bead of sealant in accordance with Section 07 92 00 - Joint Sealants.
- .9 Apply moisture barrier between wood framing members and masonry or cementitious construction.
- .10 Fit hardware accurately and securely in accordance with manufacturer's written instructions.
- .11 Make cut-outs for inset equipment and fixtures using templates provided.

3.3 CLEANING

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Leave Work area clean at end of each day.
- .2 Final Cleaning:
 - .1 Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Clean millwork and cabinet work inside cupboards and drawers and outside surfaces.
 - .3 Remove excess glue, pencil and ink marks from surfaces.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 00 - Cleaning and Waste Management.

3.4 PROTECTION

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

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Firestopping and smoke seal systems installed throughout the Work, except as otherwise indicated.

1.2 **SYSTEM DESCRIPTION**

- .1 Provide firestop and smoke seal systems consisting of a material or combination of materials installed to retain the integrity of fire-rated construction by effectively impeding the spread of flame, smoke and/or hot gasses through penetrations, blank openings or gaps, membrane penetrations, construction joints or at perimeter fire containment in or adjacent to fire-rated barriers.
- .2 Provide also smoke sealants applied over firestopping materials or combination smoke seal/firestop seal material to form airtight barriers to retard the passage of gas and smoke.
- .3 Provide fire-resistance rating equivalent to the rating of the adjacent floor, wall or other fire separation assembly.
- .4 Provide firestopping and smoke sealant system assemblies as practical and as required to coordinate with the schedule and sequencing of Work.
- .5 Confirm locations of exposed/non-exposed firestopping/smoke seal surfaces prior to application.
- .6 Provide movement capability at movement joints in accordance with design requirements for movement joint.

1.3 **DEFINITIONS**

- .1 Fire Stop Material: Device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: Fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: Exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- .4 Tightly Fitted (in accordance with applicable building code and authority having jurisdiction (AHJ):
 - .1 Penetrating items that are cast in place in buildings of non-combustible construction or have "0" annular space in buildings of combustible construction.
 - .2 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.4 **SUBMITTALS**

- .1 Provide submittals in accordance with Section 013300 - Submittal Procedures.
- .2 Prior to submitting data, review with authority having jurisdiction to confirm acceptability of proposed materials and assemblies.

- .3 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications, datasheet, including product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Show proposed material, rating and application of material for use in rated separation, reinforcement, anchorage, fastenings and method of installation, compliance with listed standards.
 - .2 Construction details should accurately reflect actual job conditions.
 - .3 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at the Project site, include manufacturer's printed instructions for installation.
- .4 Shop Drawings:
 - .1 Submit Shop Drawings to show location, proposed material, reinforcement, anchorage, fastenings and method of installation.
 - .2 Construction details should accurately reflect actual site conditions.
 - .3 Shop Drawings must clearly indicate if more than one (1) manufacturer is being used to provide firestopping Products for this Project.
- .5 Samples: Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for Project.
- .6 Quality Assurance Submittals:
 - .1 Submit in accordance with Section 014500 - Quality Control.
 - .2 Test Reports:
 - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
 - .2 Firestop system installation must meet requirements of CAN4-S115-M or ULC S-115-M tested assemblies that provide fire ratings necessary.
 - .3 Submit test results in accordance with and CAN-ULC-S102 for surface burning characteristics.
 - .4 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local AHJ for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.
 - .3 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .4 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
 - .5 Manufacturer's Field Reports: Submit to manufacturer's written reports within three (3) days of review, verifying compliance of Work, as described herein.
- .7 Schedule: Submit a complete firestopping and smoke seal schedule within fourteen (14) days of award of Contract for review. Schedule is to include complete details, cut sheets, system descriptions and location of each proposed firestopping and smoke seal application.

1.5 QUALITY ASSURANCE

- .1 Installer Qualifications: Specializing in fire stopping installations with a minimum five (5) years' documented experience and approval by manufacturer.
- .2 Pre-Installation Meetings: Convene pre-installation meeting one (1) week prior to beginning Work of this Section to:
 - .1 Verify Project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .3 Site Meetings:
 - .1 As part of manufacturer's services described herein schedule Project site visits, to review Work, at stages listed.
 - .2 After delivery and storage of Products and when preparatory Work is complete, but before installation begins.
 - .3 Twice during progress of Work at 25 % and 60 % complete.
 - .4 Upon completion of Work, after cleaning is carried out.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, Shipping, Handling and Unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to the Project site in undamaged condition and in original unopened containers, marked to indicate, manufacturer, ULC markings.
- .2 Storage and Protection:
 - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .3 Waste Management and Disposal: Separate waste materials for reuse in accordance with Section 01 74 00 - Cleaning and Waste Management.

1.7 WARRANTY

- .1 Submit two (2) copies of written two (2) year warranty agreeing to repair or replace firestopping which fails to perform as airtight and watertight joints or fails in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance or general durability or appears to deteriorate in manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated.
- .2 Provide warranty signed by the installer and Contractor.

Part 2 Products

2.1 **MATERIALS**

- .1 Fire Stopping and Smoke Seal Systems:
 - .1 In accordance with CAN4-S115-M85 or CAN-ULC-S115.
 - .2 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN4-S115-M85 or CAN-ULC-S115 and not exceed opening sizes for which they are intended.
 - .3 Non-corrosive.
 - .4 Composition documented to prevent bacteria growth.
- .2 Service Penetration Assemblies: Systems certified by test laboratory in accordance with CAN4-S115-M85 and listed in CAN-ULC-S115.
- .3 Service Penetration Fire Stop Components: Certified by test laboratory in accordance with CAN4-S115-M85 and listed in CAN-ULC-S115.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with Ontario Building Code (OBC).
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables to be elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control to be elastomeric seal.
- .7 Primers to manufacturer's recommendation for specific material, substrate and end use.
- .8 Water (if applicable): Potable, clean and free from injurious amounts of deleterious substances.
- .9 Damming and backup materials, supports and anchoring devices to manufacturer's recommendations and in accordance with tested assembly being installed as acceptable to AHJ.
- .10 Sealants for Vertical Joints: Non-sagging.
- .11 Colour: If range available to Consultant's choice of standard colours, generally to match background colour where visible in finished spaces.

2.2 **FIRE-RESISTIVE JOINT SYSTEMS**

- .1 Where required, provide fire-resistive joint systems, produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- .2 Joints in or between Fire-Resistance-Rated Construction:
 - .1 Provide fire-resistive joint systems with ratings determined per code.
 - .2 Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
 - .3 Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
- .3 Joints at Exterior Curtainwall/Floor Intersections: Provide fire-resistive joint systems with rating determined by code; equal to or exceeding the fire-resistance rating of the floor assembly.

- .4 Joints in Smoke Barriers: Prove fire-resistive joint system with ratings determined by AHJ.
- .5 Accessories: Provide components of fire-resistive joint systems, including primers and forming materials that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

Part 3 Execution

3.1 **MANUFACTURER'S INSTRUCTIONS**

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

3.2 **PREPARATION**

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

3.3 **COORDINATION**

- .1 Coordinate construction of openings and penetrations to ensure that the fire stop systems are installed according to specified requirements.
- .2 Coordinate sizing of sleeves, openings, core-drilled holes or cut openings to accommodate through-penetration fire stop systems.
- .3 Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

3.4 **INSTALLATION**

- .1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory or Omega Point Laboratories Directory.
- .2 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .3 Seal holes or voids made by through penetrations, poke-through termination devices and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .4 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 neat finish.
- .6 Remove excess compound promptly as work progresses and upon completion.

3.5 SEQUENCES OF OPERATION

- .1 Proceed with installation only when submittals have been reviewed by.
- .2 Install floor fire stopping before interior partition erections.
- .3 Metal deck bonding: fire stopping to precede spray applied fireproofing to ensure required bonding.
- .4 Mechanical Pipe Insulation:
 - .1 Certified fire stop system component.
 - .2 Ensure pipe insulation installation precedes fire stopping.

3.6 IDENTIFICATION

- .1 The firestopping applicator is to supply documentation for each single application addressed. This documentation is to identify each penetration and joint location on the entire project. Copies of these documents are to be provided to the Contractor at the completion of the Project. Each documentation form is to include:
 - .1 A sequential location number.
 - .2 The Project name.
 - .3 Date of installation.
 - .4 Detailed description of the penetration's location.
 - .5 Tested system or engineered judgment number.
 - .6 Type of assembly penetrated.
 - .7 A detailed description of the size and type of penetrating item.
 - .8 Size of opening.
 - .9 Number of sides of assemblies addressed.
 - .10 Hourly rating to be achieved.
 - .11 Installers name.
- .2 Identify through-penetration firestopping and smoke seal systems with pressure- sensitive, self-adhesive, printed vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestopping system installation where labels will be visible to anyone seeking to remove penetrating items or firestopping and smoke seal systems. Include the following information on labels:
 - .1 The words "Warning - Through-Penetration Firestopping System - Do Not Disturb".
 - .2 Applicator's name, address and telephone number.
 - .3 Designation of applicable testing and inspection agency.
 - .4 Date of installation.
 - .5 Manufacturer's name for firestopping and smoke seal system materials.

3.7 FIELD QUALITY CONTROL

- .1 Inspections: Notify Consultant when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

- .2 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.
- .3 Perform under this Section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.
- .4 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit manufacturer's field reports as described herein.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of Product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as specified herein.

3.8 **INDEPENDENT INSPECTION AND TESTING**

- .1 Arrange independent inspection and testing of Work of this Section. Pay costs from allowance established for this purpose.
- .2 Independent inspection agency shall:
 - .1 Inspect representative examples of each type of fire stops and smoke seals prior to being enclosed or covered.
 - .2 Make representative tests and investigations of completed Work of this Section to ascertain conformance with manufacturer's requirements and performance criteria. Contractor shall make and repair test openings.
- .3 Contractor shall schedule and arrange inspections, providing sufficient advance notice to independent inspection and testing agency. Uncover Work of this Section which has not been subject to independent inspection and testing.
- .4 Independent inspection and testing agency shall issue written reports, copied to Owner, building department, Contractor and Consultant.

3.9 **CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.10 **SCHEDULE**

- .1 Fire stop and smoke seal at:
 - .1 Penetrations through fire-resistance rated masonry, concrete and gypsum board partitions and walls.
 - .2 Edge of floor slabs at curtain wall and precast concrete panels.
 - .3 Top of fire-resistance rated masonry and gypsum board partitions.
 - .4 Intersection of fire-resistance rated masonry and gypsum board partitions.

- .5 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
- .6 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
- .7 Openings and sleeves installed for future use through fire separations.
- .8 Around mechanical and electrical assemblies penetrating fire separations.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Security sealants.

1.2 **DEFINITIONS**

- .1 Environmental Product Declaration (EPD): Submit an Industry-wide EPD for each metal product outlined in the specification. Provide EPD with at least a cradle to gate scope, identifying the following impact categories (minimum):
 - .1 Global Warming Potential (GWP): Submit GWP information in the form of kgCO₂ eq.
 - .2 Ozone Depletion Potential (ODP): Submit ODP information in the form of kgCFC-11 eq.
 - .3 Acidification Potential (AP): Submit AP information in the form of kgSO₂ eq.
 - .4 Eutrophication Potential (EP): Submit EP information in the form of kgN eq.
 - .5 Smog Formation Potential (SFP): Submit SFP information in the form of kgO₃ eq. Also referred to as Photochemical ozone creation potential (POCP).

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's product data for each type of primer, backer rod and security sealants and include product characteristics, performance criteria, available colours, compatibility warnings, compliance standards and limitations.
 - .2 Submit one (1) electronic copy of Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS).
- .3 Samples:
 - .1 Submit two (2) samples of each type of joint sealant material and colour.
 - .2 Submit two (2) cured samples of exposed security sealants of each colour to match adjacent material.
- .4 Certificates: When requested by Consultant, submit manufacturer's product certificates indicating proposed security sealant is appropriate for each application on this Project.
- .5 Manufacturer's Instructions: Submit instructions for each type of product.

1.4 **CLOSEOUT SUBMITTALS**

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

1.5 **QUALITY ASSURANCE**

- .1 Qualifications:
 - .1 Manufacturer:
 - .1 Obtain each type of joint sealant from a single manufacturer.
 - .2 Minimum ten (10) years successful experience in Work of similar size and complexity.
 - .2 Compatibility: Ensure security sealants are compatible with adjacent materials and are approved by manufacture for use with adjacent materials.
 - .3 Installer Qualifications: Engage installers trained, accepted and approved by the security sealant manufacturer.
 - .4 Mock-Ups:
 - .1 Construct mockup in accordance with Section 01 40 00 - Quality Requirements.
 - .2 Before performing security sealant work do sample applications of each type of security sealant for review.
 - .3 Site locations for sample applications shall be designated by Consultant.
 - .4 Construct joint sealant mock-ups in assemblies of other sections with joint sealants, which are referenced in this section.
 - .5 Comply with requirements of WHMIS regarding use, handling, storage and disposal of hazardous materials; and regarding labelling and provision of SDS acceptable to Health Canada.

1.6 **DELIVERY, STORAGE AND HANDLING**

- .1 Perform in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: Deliver materials to Project site in original factory packaging, with manufacturer's label.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a ventilated dry indoor location and in accordance with manufacturer's recommendations.
 - .2 Handle and dispose of hazardous materials in accordance with the Canadian Environmental Protection Act (CEPA), Transportation of Dangerous Goods Act (TDGA), regional and municipal regulations.
 - .3 Do not dispose of unused security sealant material into sewer system, streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
 - .4 Divert unused joint sealing material from landfill to official hazardous material collections site approved by Consultant.

1.7 **AMBIENT CONDITIONS**

- .1 Proceed with installation of joint sealants only when:
 - .1 Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer or are above 4.4°C.
 - .2 Joint substrates are dry.

- .3 Conform to manufacturer's recommended temperatures, relative humidity and substrate moisture content for application and curing of security sealants including special conditions governing use.
 - .2 Ventilate area of work as directed by Consultant by use of approved portable supply and exhaust fans.
- 1.8 **WARRANTY**
 - .1 Special Installer's Warranty:
 - .1 Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - .2 Warranty Period: Two (2) years from date of Substantial Completion.
 - .2 Special Manufacturer's Warranty:
 - .1 Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - .2 Warranty Period: Five (5) years from date of Substantial Completion.
 - .3 Special warranties specified herein exclude deterioration or failure of joint sealants from the following:
 - .1 Movement of the structure caused by stresses on the security sealant exceeding security sealant manufacturer's written specifications for security sealant elongation and compression.
 - .2 Disintegration of joint substrates from causes exceeding design specifications.
 - .3 Mechanical damage caused by individuals, tools, or other outside agents.
 - .4 Changes in security sealant appearance caused by accumulation of dirt or other atmospheric contaminants.
- Part 2 Products
 - 2.1 **PERFORMANCE REQUIREMENTS**
 - .1 Compatibility: Provide rigid joint sealants, primers, backings, and accessory materials that are compatible with one (1) another and with Project joint substrates.
 - .2 Each security sealant system shall meet the following requirements for warranty period:
 - .1 Waterproof, flexible and compatible with substrate under applicable service conditions.
 - .2 Provide a weather-tight seal that does not allow moisture penetration.
 - .3 Shall not de-bond, crack or craze.
 - .4 Shall not leak.
 - 2.2 **SEALANT MATERIALS**
 - .1 In air handling units and supply air system, use security sealants without strong odours, without toxic chemicals and are mould resistant. When low toxicity security sealants are not possible, confine usage to areas which off gas to exterior, are contained behind air barriers or are applied several months before occupancy to maximize off gas time.

- .2 Provide primers in accordance with manufacturer recommendation.

2.3 SECURITY JOINT SEALANTS

.1 Pickproof (tamperproof) Sealant:

.1 Multicomponent, Non-sag, Epoxy Resin Security Joint Sealant:

- .1 Acceptable Product: "DynaPoxy EP-1200" as manufactured by Pecora Corporation <https://www.pecora.com>.
- .2 Compliance: ASTM C 881, Types I and III, Grade 3, Classes B and C.
- .3 Physical Properties:
 - i. Compression Strength: 75.8 MPa (11000 psi) in accordance with ASTM D 695.
 - ii. Bond Strength: 24.3 MPa (3530 psi) in accordance with ASTM C 882.
 - iii. Shore A Hardness: Greater than 90 in accordance with ASTM C 661.
 - iv. Dynamic Movement Capability: None in accordance with ASTM C 719.

.2 Multicomponent, Non-sag, Epoxy Resin Security Joint Sealant:

- .1 Acceptable Product: "Sikadur 31" as manufactured by Sika Canada <https://can.sika.com>.
- .2 Compliance: ASTM C 881, Types VI, and ASBI guidelines.
- .3 Physical Properties:
 - i. Compression Strength in accordance with ASTM D 695:
 - 1. 13.8 MPa (2000 psi) at twenty-four (24) hours.
 - 2. 48.3 MPa (7000 psi) at forty-eight (48).
 - ii. Bond Strength: 6.9 MPa (1000 psi) in accordance with ASTM C 882.
 - iii. Shore A Hardness: Greater than 90 in accordance with ASTM C 661.
 - iv. Dynamic Movement Capability: None in accordance with ASTM C 719.

.2 Tamper Resistant Sealant:

.1 Multicomponent, Non-sag, Polyurethane Security Joint Sealant:

- .1 Acceptable Product: "DynaFlex" as manufactured by Pecora Corporation.
- .2 Compliance: ASTM C 920, Type M Grade NS Class 12.5, Uses TI, M, O.
- .3 Physical Properties:
 - i. Tensile Strength: 2.1 to 2.4 MPa (300 to 350 psi) in accordance with ASTM D 412.
 - ii. Shore A Hardness: 55 plus or minus 5 in accordance with ASTM C 661.

- iii. Dynamic Movement Capability: 12.5% in accordance with ASTM C 719.
- .2 Multicomponent, Non-sag, Epoxy Resin Security Joint Sealant:
 - .1 Acceptable Product: "SikaFlex 11 FC" as manufactured by Sika Canada.
 - .2 Compliance: ASTM C 881, Types VI, and ASBI guidelines.
 - .3 Technical Information:
 - i. Shore A Hardness: ~37 (after twenty-eight [28] days) (ISO 868).
 - ii. Tensile Strength: ~1,5 N/mm² (ISO 37).
 - iii. Secant Tensile Modulus: ~0,60 N/mm² at 100 % elongation (+23 °C) (ISO 8339).
 - iv. Elongation at Break: ~700 % (ISO 37).
 - v. Movement Capability: ±35 % (ASTM C 719).
 - vi. Elastic Recovery: ~80 % (ISO 7389).
 - vii. Tear Propagation Resistance: ~8,0 N/mm (ISO 34).
 - viii. Service Temperature: -40 °C minimum / +80°C maximum.

2.4 SEALANT SELECTION

- .1 Where no specific type of security sealant is scheduled, provide one (1) of the security sealants indicated herein appropriate for its application and consistent with manufacturer's recommendations and the recommendations of Sealant, Waterproofing and Restoration Institute (SWRI), Sealants: The Professionals' Guide.
- .2 Make security sealant selections consistent with manufacturer's recommendations.

2.5 ACCESSORIES

- .1 Preformed compressible and non-compressible back-up materials that are non-staining, compatible with joint substrate, security sealants, primers and other joint fillers and are approved for applications indicated by security sealant manufacturer based on site experience and laboratory testing:
 - .1 Rod type security sealant backings for security sealants, as required by the security sealant manufacturer.
 - .2 Bond Breaker Tape: Polyethylene bond breaker tape or other tape recommended by security sealant manufacturer which will not bond to security sealant.
- .2 Bond Breaker: Pressure-sensitive plastic tape that will not bond to security sealants as recommended by the security sealant manufacturer.
- .3 Joint Cleaner: Provide a non-corrosive and non-staining type, compatible with joint forming materials and security sealant in accordance with security sealant manufacturer's recommendations.
- .4 Primer: Provide in accordance with security sealant manufacturer's recommendations.
- .5 Masking Tape: Non-absorbent type, non-staining, compatible with joint sealant and joint substrates as recommended by the security sealant manufacturer.

2.6 **COLOURS**

- .1 Security Sealant Colours: As selected from manufacturer's standard range.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Verification of Conditions:
 - .1 Verify that conditions of substrate previously installed are acceptable for joint sealants installation in accordance with manufacturer's instructions.
 - .2 Visually inspect substrate.
 - .3 Verify joint surfaces are dry and frost free.
 - .4 Verify substrates are without contaminants capable of interfering with security sealant adhesion. Remove contaminants where occurring.
 - .5 Examine joint sizes and conditions to establish acceptable depth to width ratio for installation of backup materials and application of security sealants.
 - .6 Verify joint widths are within the limits recommended by joint sealant manufacturer for applications indicated.
 - .7 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .8 Proceed with installation only after unacceptable conditions have been remedied.

3.2 **SURFACE PREPARATION**

- .1 Clean bonding joint surfaces of harmful contaminants including dust, rust, oil grease and other matter which may impair adhesion.
- .2 Do not apply security sealants to joint substrates treated with sealer, curing compound, water repellent or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .3 Prepare surfaces in accordance with manufacturer's directions.

3.3 **PRIMING**

- .1 Mask adjacent surfaces prior to priming and sealing where necessary to prevent staining.
- .2 Prime sides of joints in accordance with security sealant manufacturer's instructions immediately applying security sealant, except when manufacturer's instructions explicitly state priming is not required.
- .3 Prime porous material (e.g., wood, masonry, concrete, ceramic or paver tile, etc.).

3.4 **BACK-UP MATERIAL**

- .1 Provide backer rod as specified, to limit depth of security sealant and to act as bond breaker at back of joint.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

- .3 Apply paper masking tape to back of joint to act as bond break where depth of joint does not permit the use of backer rod.
- .4 Ensure that no joints are formed which are bonded on adjacent sides where there is any possibility of movement.

3.5 **MIXING**

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

3.6 **APPLICATION**

- .1 Security Sealant: Application: Apply security sealants to recommendations of ASTM C1193, and in accordance with manufacturer's instructions and as follows:
 - .1 Apply security sealant within recommended temperature ranges. Consult manufacturer when security sealant cannot be applied within recommended temperature range.
 - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .3 For joints where movement is possible, apply backer rod to achieve a joint depth of one half ($\frac{1}{2}$) the joint width but not less than 9 mm; for joints larger than 1" (25 mm) use a depth of $\frac{1}{2}$ " (13 mm).
 - .4 Apply security sealant in a continuous bead.
 - .5 Apply security sealant using gun with proper size nozzle.
 - .6 Fill voids and joints solid.
 - .7 Form security sealant surface with a smooth full bead, without from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .8 Tool exposed surfaces before skinning begins to give slightly concave shape.
 - .9 Ensure bead is solid, filling entire space between sides and bedding material, exerting sufficient pressure to obtain maximum bond, by allowing security sealant to bulge out in advance of nozzle.
 - .10 Apply security sealant within recommended temperature ranges. Consult manufacturer when security sealant cannot be applied within recommended temperature range.
 - .11 Seal at locations where dissimilar material meet.
 - .12 Apply security sealants in strict accordance with manufacturers printed instructions.
- .2 Security Sealant Curing:
 - .1 Cure security sealants in accordance with security sealant manufacturer's instructions.
 - .2 Do not cover up security sealants until after curing has completed.

3.7 **CLEANING**

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.

- .2 Clean adjacent surfaces immediately of excess primers and security sealants.
- .3 Remove excess and droppings, using recommended cleaners as work progresses.
- .4 Remove masking tape after initial set of security sealant.
- .2 Final Cleaning: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management upon completion.
- .3 Waste Management:
 - .1 Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Do not dispose of unused security sealant materials into sewer system, streams, lakes, onto ground or other location where it might pose a health or environmental hazard.
 - .3 Divert unused security sealants from landfill to a hazardous material collection site.
 - .4 Place materials defined as hazardous or toxic in designated containers.
 - .5 Dispose of hazardous materials in accordance with the CEPA, TDGA, regional and municipal regulations.

3.8 PROTECTION

- .1 Protect installed Products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by joint sealants installation.
- .3 Seal perimeters of hollow metal door frames on both sides.
- .4 Seal control joints in gypsum wallboard (GWB), except where prefabricated control joints are specified.
- .5 Seal junctures between interior partitions with exterior walls.
- .6 Seal window and door frames around the inside perimeter, so that an airtight seal is obtained, as indicated on Drawings.
- .7 Seal joints in floors and walls and around service and mechanical and electrical fixture penetrations.
- .8 Perimeter of bath fixtures (e.g., sinks, tubs, urinals, water closets, basins, vanities).
- .9 Seal interior perimeters of exterior openings as detailed on Drawings.
- .10 Interior control and expansion joints in floor surfaces.
- .11 Perimeters of interior frames, as detailed.
- .12 Exposed interior control joints in GWB.
- .13 Seal at locations where dissimilar material meet.
- .14 Refer to Section 07 84 00 – Fire Stopping for additional requirements.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Interior standard steel doors and frames.
- .2 Interior custom hollow-metal doors and frames.

1.2 **SYSTEM DESCRIPTION**

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

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data.
- .3 Submit Shop Drawings.
 - .1 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazed louvred, arrangement of hardware and fire rating and finishes.
 - .2 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings and reinforcing, fire rating and finishes.
 - .3 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.
 - .4 Submit test and engineering data, and installation instructions.
- .4 Submit samples.
- .5 Submit one 305 x 305 mm corner sample of each type of frame. Show butt cutout glazing stops 305 mm long removable mullion connection.

1.4 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Separate waste materials for reuse and recycling in accordance with Section 01 74 00 - Cleaning and Waste Management.

Part 2 Products

2.1 **MATERIALS**

- .1 Hot Dipped Galvanized Steel Sheet: To ASTM A653M, ZF75, minimum base steel thickness in accordance with Canadian Steel Door Manufacturers Association (CSDMA) Table 1 - Thickness for Component Parts.

- .2 Reinforcement Channel: To CSA G40.20/G40.21, Type 44W, coating designation to ASTM A653M, ZF75.
- .3 Composites: Balance of core materials used in conjunction with lead in accordance with manufacturers' proprietary design.

2.2 DOOR CORE MATERIALS

- .1 Stiffened:
 - .1 Face sheets welded.
 - .2 Fibreglass: Polyurethane cores to CAN/ULC-S704 rigid, modified polyisocyanurate, closed cell board. Density 32 kg/m³. Locations as indicated on the Drawings.
- .2 Temperature rise rated (TRR): core composition to limit temperature rise on unexposed side of door to 250°C at sixty (60) minutes. Core to be tested as part of a complete door assembly, in accordance with CAN/ULC-S104, or NFPA 252, covering Standard Method of Tests of Door Assemblies and listed by nationally recognized testing agency having factory inspection service.

2.3 ADHESIVES

- .1 Honeycomb Cores and Steel Components:
 - .1 Heat resistant, spray grade, resin reinforced neoprene/ polychloroprene based, low viscosity, contact cement.
 - .2 Adhesive: maximum volatile organic compound (VOC) content 50 g/L to SCAQMD Rule 1168.
- .2 Polystyrene and Polyurethane Cores: Heat resistant, epoxy resin based, low viscosity, contact cement.
- .3 Lock-Seam Doors: Fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

2.4 PRIMER

- .1 Touch-up prime CAN/CGSB-1.181
- .2 Maximum VOC limit 50 g/L to GC-03.

2.5 PAINT

- .1 Site paint steel doors and frames in accordance with Sections 09 91 23 - Interior Painting. Protect weatherstrips from paint. Provide final finish free of scratches or other blemishes.
- .2 Maximum VOC emission level 50 g/L to SCAQMD Rule 1113.

2.6 ACCESSORIES

- .1 Door silencers: single stud rubber/neoprene type.
- .2 Interior top and bottom caps: Steel.
- .3 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.

- .4 Metallic paste filler to manufacturer's standard.
- .5 Fire Labels: Metal riveted.
- .6 Sealant: Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .7 Glazing: As indicated on the Drawings.
- .8 Make provisions for glazing as indicated and provide necessary glazing stops.
 - .1 Provide removable stainless steel glazing beads for use with glazing tapes and compounds and secured with countersunk stainless-steel screws.
 - .2 Design glazing stops to be tamperproof.

2.7 **FRAMES FABRICATION - GENERAL**

- .1 Fabricate frames in accordance with CSDMA specifications.
- .2 Fabricate frames to profiles and maximum face sizes as indicated.
- .3 Interior frames: 1.6 mm welded type construction.
- .4 Blank, reinforce, drill and tap frames for mortised, templated hardware, and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.
- .5 Protect mortised cutouts with steel guard boxes.
- .6 Prepare frame for door silencers, three (3) for single door, two (2) at head for double door.
- .7 Manufacturer's nameplates on frames and screens are not permitted.
- .8 Conceal fastenings except where exposed fastenings are indicated.
- .9 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.

2.8 **FRAME ANCHORAGE**

- .1 Provide appropriate anchorage to floor and wall construction.
- .2 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.
- .3 Provide two (2) anchors for rebate opening heights up to 1520 mm and one (1) additional anchor for each additional 760 mm of height or fraction thereof.
- .4 Locate anchors for frames in existing openings not more than 150 mm from top and bottom of each jambs and intermediate at 660 mm on centre maximum.

2.9 **FRAMES - WELDED TYPE**

- .1 Welding in accordance with CSA W59
- .2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.
- .3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.
- .4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.

- .5 Securely attach floor anchors to inside of each jamb profile.
- .6 Weld in two (2) temporary jamb spreaders per frame to maintain proper alignment during shipment.
- .7 Fabricate frame products for openings in sections, splice joints for site assembly.
- .8 Securely attach lead to inside of frame profile from return to jamb soffit (inclusive) on door side of frame only.

2.10 DOOR FABRICATION - GENERAL

- .1 Doors: swing type, flush, with provision for glass and/or louvre openings as indicated.
- .2 Fabricate doors with longitudinal edges welded. Seams: Grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.
- .3 Doors: Manufacturers' proprietary construction tested and/or engineered as part of a fully operable assembly, including door, frame, gasketing and hardware in accordance with ASTM E330.
- .4 Blank, reinforce, drill doors and tap for mortised, templated hardware and electronic hardware.
- .5 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, on site, at time of hardware installation.
- .6 Reinforce doors where required, for surface mounted hardware. Provide flush steel top caps to doors. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.
- .7 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.
- .8 Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in conformance with CAN/ULC-S104 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
- .9 Manufacturer's nameplates on doors are not permitted.

2.11 DOORS - CORE CONSTRUCTION

- .1 Form face sheets for interior doors from 1.6 mm sheet steel with **[temperature rise rated]** core laminated under pressure to face sheets.

2.12 HOLLOW STEEL CONSTRUCTION

- .1 Form face sheets for interior doors from 1.6 sheet steel.
- .2 Reinforce doors with vertical stiffeners, securely welded to face sheets at 150 mm on centre maximum.
- .3 Fill voids between stiffeners of interior doors with temperature rise rated core.

Part 3 Execution

3.1 INSTALLATION - GENERAL

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

- .2 Install doors and frames to CSDMA Installation Guide.

3.2 **FRAME INSTALLATION**

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

3.3 **DOOR INSTALLATION**

- .1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Doors Hardware.
- .2 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows:
 - .1 Hinge Side: 1 mm.
 - .2 Latchside and Head: 1/16" (1.5 mm).
 - .3 Finished Floor: 1/2" (13 mm).
- .3 Adjust operable parts for correct function.
- .4 Install louvres.

3.4 **FINISH REPAIRS**

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

3.5 **GLAZING**

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

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Non-rated access doors in walls and partitions
- .2 Fire-protection rated access doors in walls and partitions
- .3 Non-rated access doors in ceilings
- .4 Fire-protection rated access doors in ceilings

1.2 **ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination:
 - .1 Coordinate with Section 08 71 00 - Door Hardware for door lock cylinders.
 - .2 Coordinate framing dimensions and installation of access doors and panels in walls and partitions with Section 09 21 16 - Gypsum Board Assemblies.
 - .3 Coordinate installation of access doors and panels with Section 09 30 00 - Tiling.
 - .4 Coordinate work of mechanical and electrical Subcontractors to avoid where possible locating access doors and panels that may conflict with their work.
- .2 Pre-installation Meetings:
 - .1 Hold a meeting in accordance with Section 01 31 19 – Project Meetings.
 - .2 Attended by Contractor, Subcontractor responsible for this Section, mechanical Subcontractor, Consultant and other Subcontractors affected by Work of this Section.
 - .3 Agenda: Discuss locations and types of access doors and panels and obtain Consultant's acceptance of doors and panels in prominent locations (e.g., feature ceilings, main reception area, feature staircase).

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's product data for each type of access door and panel components. Indicate door designation, type and model, product characteristics, fabrication details, dimensions, latching and locking types, fire-protection rating and sound transmission class (STC) rating and finishes.
 - .2 Submit Workplace Hazardous Materials Information System (WHMIS) safety data sheet (SDS).
- .3 Shop Drawings:
 - .1 Submit a Shop Drawing of reflected ceiling plan, drawn to scale. Indicate ceiling-mounted items and items penetrating ceiling, including but not limited to access doors and panels, diffusers, grilles, light fixtures, emergency lighting, speakers and sprinkler heads.
 - .2 Submit access door and panel schedule. Include types, general locations specific room numbers, dimensions, latching and locking types.
- .4 Samples:
 - .1 Submit each type of unit for review and acceptance.

- .2 Samples will not be returned for inclusion into work
- .3 Submit each type of hand entry access door and panel.
- .4 Submit one (1) 300 x 300 mm corner sample of each type of body entry door.
- .5 Manufacturers' Instructions: Submit manufacturer's installation instructions.

1.4 **CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Supply two (2) keys for each cylinder lock and ensure access panels are keyed alike, unless instructed otherwise.
- .3 Warranty Documentation: Submit manufacturer's warranty.

1.5 **QUALITY ASSURANCE**

- .1 Qualifications:
 - .1 Manufacturer: Ten (10) years manufacturing access doors similar to those required for this Project. Obtain each type of access door and panel from a single manufacturer.
 - .2 Installers: Five (5) years of experience installing access doors and panels of similar complexity and scope to that required for the Project.
 - .3 Testing Agencies: Provide fire-protection rated doors and panels manufactured under the label service program of a testing agency accredited by the Standards Council of Canada.

1.6 **DELIVERY, STORAGE AND HANDLING**

- .1 Perform in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to the Project site in original factory packaging with manufacturer's labels.
 - .2 Provide temporary protection during delivery and site storage to prevent distortion, surface damage and rust.
 - .3 After arrival on Project site, immediately remove wet wrapping materials, inspect doors and panels for damage and notify delivery company and supplier if damage is found.
 - .4 Minor damage may be repaired if refinished products match new work and are acceptable to Consultant.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in a dry interior location away from direct sunlight, in a way that prevents sagging, bowing or twisting and in accordance with manufacturer's recommendations.
 - .2 Store and protect access doors and panels from nicks, scratches, distortion and rust.

1.7 **SITE CONDITIONS**

- .1 Site Measurements: Before fabrication, verify actual dimensions of openings by measuring on site and indicate actual measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- .2 Established Dimensions: When site measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating access doors and panels without site measurements. Coordinate site construction to ensure that actual site dimensions correspond to established dimensions.

1.8 **WARRANTY**

- .1 Manufacturer's Warranty: One (1) year warranty, free from defects in material and manufacturing.

Part 2 Products

2.1 **REGULATORY REQUIREMENTS**

- .1 Rated Access Doors and Panels:
 - .1 At fire-resistance rated partition and ceiling assemblies, provide access door and panel assemblies (comprising doors, frames, hardware and other components of the Closure) complying with CAN/ULC-S104 or NFPA 80 with a fire-protection rating to suit the surrounding assembly.
 - .2 Labelled and listed by UL, ULC, ITS Warnock Hersey or other inspecting agency acceptable to authority having jurisdiction (AHJ). Affix appropriate label to each unit indicating the labelling requirement.

2.2 **MATERIALS**

- .1 Steel Sheet: To ASTM A1008/A1008M.
- .2 Galvannealed Steel: To ASTM A653/A653M.

2.3 **FIRE-RATED ACCESS DOORS AND FRAMES**

- .1 Fire-Rated, Flush Access Doors with Exposed Flanges:
 - .1 Basis-of-Design Product: Subject to compliance with requirements, provide Model "PFN-85 - Fire-Rated Uninsulated Access Door" as manufactured by Cendrex Inc. <https://cendrex.com> or a comparable product by one (1) of the following:
 - .1 Babcock-Davis <https://www.babcockdavis.com>.
 - .2 JL Industries <https://www.jl-industries.com>.
 - .3 Maxam Metal Products Ltd. <https://maxammetal.com>.
 - .2 Description: Door face flush with frame, uninsulated; with exposed flange, self-closing door and concealed hinge.
 - .3 Locations: Wall and ceiling.
 - .4 Door Size: As indicated on the Drawings.
 - .5 Fire-Resistance Rating: Not less than that of adjacent construction.
 - .6 Temperature-Rise Rating: 250°C at the end of thirty (30) minutes.

- .7 Steel Sheet for Door: Nominal 16 ga.
 - .8 Finish: Powder coat paint - white.
 - .9 Frame Material: Same material, thickness and finish as door. 2 ½" deep.
 - .10 Latch and Lock: Self-latching door hardware, prepared for mortise slam latch cylinder.
 - .11 Hinge:
 - .1 Continuous piano hinge.
 - .2 Hinges must be located on the second dimension (height).
 - .2 Fire-Rated, Access Doors with Concealed Frame:
 - .1 Basis-of-Design Product: Subject to compliance with requirements, provide Model "FDW (complete model number based on size and manufacturer's chart) - Fire-Rated Insulated Access Door" as manufactured by JL Industries or a comparable product by one (1) of the following:
 - .1 Babcock-Davis.
 - .2 Cendrex Inc.
 - .3 Maxam Metal Products Limited.
 - .2 Frame: 16 ga steel with 1" drywall bead which can be taped and mudded for a smooth appearance.
 - .3 Panel: Insulated 20 ga steel with continuous hinge, 2" thickness.
 - .4 Finish: Powder coat paint - white.
 - .5 Standard Latch/Lock: Universal turn ring and key lock "U".
 - .6 General Use: Locations as indicated on the Drawings.
 - .7 Fire-Rating:
 - .1 Walls: One and one half (1 ½) hour UL "B" label in a two (2) hour fire barrier; maximum size 4'-0" x 4'-0".
 - .2 Ceilings: Warnock Hersey listed for floor or ceiling installations with three (3) hour non-combustible rating or one (1) hour combustible rating; maximum size 2'-0" x 3'-0".
 - .8 Style FDW Options:
 - .1 Color: As selected by the Consultant.
 - .2 Frame and Panel Material: Galvanized steel.
 - .3 Lock Feature: Mortise Slam Lock installed (U4).
- 2.4 **FABRICATION**
- .1 Access Door Sizes: As indicated on the Drawings.
 - .2 Fabricate access doors and panel assembly as a single unit, ready for site installation.
 - .3 Fabricate large units with enough latches to hold door flush with frame.
 - .4 Fabricate units rigid with bracing and reinforcements as required to remain square and prevent sagging.

- .5 Fabricate visible surfaces flat and smooth without embossed or imprinted manufacturer's name. Grind visible welds smooth and blended.
- .6 Touch-up factory-applied coatings and galvanized surfaces where finish was removed during fabrication.
- .7 Locate label indicating manufacturer and model **and fire-protection rating** on rear of panel door or other concealed surface(s), to NFPA 80.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Verification of Conditions:
 - .1 Verify conditions of substrates previously installed are acceptable for access doors and panels installation, in accordance with manufacturer's instructions.
 - .2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 **INSTALLATION**

- .1 Installation:
 - .1 locate access doors within view of equipment and ensure equipment is accessible for operating, inspecting, adjusting, servicing without using special tools.
 - .2 Install access doors and panels permitting access to service valves, traps, dampers, cleanouts and other mechanical, electrical and conveyor control items concealed by walls and partitions and concealed above gypsum board and acoustic panel and plaster ceilings.
- .2 Install fire protection rated access doors and panels in fire rated partitions and ceilings, in accordance with NFPA 80.
- .3 Isolate steel from direct contact with dissimilar metals, concrete and masonry with isolation coating of alkali-resistant bituminous paint, epoxy or other permanent non-corrosive material recommended by manufacturer.
- .4 Set frames square and in-plane with the substrate assembly, aligned with adjacent visible finishes. Securely attach to substrates.
- .5 Access Doors above Acoustic Panel Ceilings: Install unobtrusive identification locators, such as a small self-adhering circle on the acoustic panel.

3.3 **ADJUSTING**

- .1 Adjust access panels to operate easily without binding. Verify that integral locking devices operate properly.
- .2 Touch-up with factory-applied finishes if damaged during installation.
- .3 Repair damage to zinc coatings in accordance with ASTM A780/A780M.
- .4 Repair damage to adjacent materials caused by installation of access doors and panels.
- .5 Adjust operable parts for correct function.

3.4 CLEANING

- .1 Progress and Final Cleaning: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management and remove gypsum board compound from hinges, frames and door edges.
- .2 Waste Management: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Security access doors and frames for walls and ceilings.

1.2 **ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination:
 - .1 Coordinate with Section 08 71 00 - Door Hardware for door lock cylinders.
 - .2 Coordinate framing dimensions and installation of access doors and panels in walls and partitions with Section 09 21 16 - Gypsum Board Assemblies.
 - .3 Coordinate installation of access doors and panels with Section 09 30 00 - Tiling.
 - .4 Coordinate work of mechanical and electrical Subcontractors to avoid where possible locating access doors and panels that may conflict with their work.
- .2 Pre-installation Meetings:
 - .1 Hold a meeting in accordance with Section 01 31 19 – Project Meetings.
 - .2 Attended by Contractor, Subcontractor responsible for this Section, mechanical Subcontractor, Consultant and other Subcontractors affected by Work of this section.
 - .3 Agenda: Discuss locations and types of access doors and panels and obtain Consultant's acceptance of doors and panels in prominent locations (e.g., feature ceilings, main reception area, feature staircase).

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
- .3 Submit manufacturer's product data for each type of access door and panel components. Indicate door designation, type and model, product characteristics, fabrication details, dimensions, latching and locking types, fire-protection rating and sound transmission class (STC) rating and finishes.
- .4 Submit Workplace Hazardous Materials Information System (WHMIS) safety data sheet (SDS).
- .5 Shop Drawings:
 - .1 Submit a Shop Drawing of reflected ceiling plan, drawn to scale. Indicate ceiling-mounted items and items penetrating ceiling, including but not limited to access doors and panels, diffusers, grilles, light fixtures, emergency lighting, speakers and sprinkler heads.
 - .2 Submit access door and panel schedule. Include types, general locations specific room numbers, dimensions, latching and locking types.
- .6 Samples:
 - .1 Submit each type of unit for review and acceptance.
 - .2 Samples will not be returned for inclusion into work
 - .3 Submit each type of hand entry access door and panel.
 - .4 Submit one (1) 300 x 300 mm corner sample of each type of body entry door.

- .7 Manufacturers' Instructions: Submit manufacturer's installation instructions.

1.4 **CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Supply two (2) keys for each cylinder lock and ensure access panels are keyed alike, unless instructed otherwise.
- .3 Warranty Documentation: Submit manufacturer's warranty.

1.5 **QUALITY ASSURANCE**

- .1 Qualifications:
 - .1 Manufacturer: Ten (10) years manufacturing access doors similar to those required for this Project. Obtain each type of access door and panel from a single manufacturer.
 - .2 Installers: Five (5) years of experience installing access doors and panels of similar complexity and scope to that required for the Project.
 - .3 Testing Agencies: Provide fire-protection rated doors and panels manufactured under the label service program of a testing agency accredited by the Standards Council of Canada.

1.6 **DELIVERY, STORAGE AND HANDLING**

- .1 Perform in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to the Project site in original factory packaging with manufacturer's labels.
 - .2 Provide temporary protection during delivery and site storage to prevent distortion, surface damage and rust.
 - .3 After arrival on Project site, immediately remove wet wrapping materials, inspect doors and panels for damage and notify delivery company and supplier if damage is found.
 - .4 Minor damage may be repaired if refinished products match new work and are acceptable to Consultant.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in a dry interior location away from direct sunlight, in a way that prevents sagging, bowing or twisting and in accordance with manufacturer's recommendations.
 - .2 Store and protect access doors and panels from nicks, scratches, distortion and rust.

1.7 **SITE CONDITIONS**

- .1 Site Measurements: Before fabrication, verify actual dimensions of openings by measuring on site and indicate actual measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

- .2 Established Dimensions: When site measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating access doors and panels without site measurements. Coordinate site construction to ensure that actual site dimensions correspond to established dimensions.

1.8 **WARRANTY**

- .1 Manufacturer's Warranty: One (1) year warranty, free from defects in material and manufacturing.

Part 2 **Products**

2.1 **HIGH SECURITY ACCESS DOORS AND FRAMES**

- .1 Style HSP:
 - .1 Flat frame, high security type, steel access panel.\
 - .2 Model No.: PFI Series Fire Rated Access Door, "ALN-GYP" as manufactured by Cendrex Industries Inc. <https://cendrex.com>. Anti-ligature door with gypsum wallboard (GWB) bead flange.
 - .3 Frame: Steel angle frame, 2" x 3" x 3/16" (50.8 x 76.2 x 4.7625 mm) with 2" (50.8 mm) flange, welded at corners.
 - .4 Panel: 7 ga box-formed steel door mounted on two (2) heavy-duty 4" (101.6 mm) butt hinges which are welded to the frame.
 - .5 Finish: Powder coat paint - white.
 - .6 Anchors: Heavy-duty steel or stainless steel (match frame and panel material) masonry anchors factory-welded to frame.
 - .7 Style HSP Options:
 - .1 Frame and Panel Color (Paint): As indicated on the Drawings.
 - .2 Lock Prep and Lock Features:
 - .1 Detention Deadlock Installed (DDI5010). Keys: Provide 2 keys.
 - .2 Detention Slam Lock Installed (DDI5017). Keys: Provide 2 keys.
 - .3 Mortise Deadbolt Installed (MDP-SL-AMP) or (MDP-SL-1E74) as selected by the Consultant.
 - .4 Mortise Cylinder Cam Lock Installed (MCP-SL-AMP) or (MCP-SL-1E74) as selected by the Consultant.

2.2 **MATERIALS**

- .1 Steel Plates, Shapes and Bars: ASTM A36/A36M.
- .2 Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- .3 Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- .4 Stainless Steel Plate, Sheet and Strip: ASTM A240/A240M or ASTM A666, Type 304. Remove tool and die marks and stretch lines or blend into finish.

- .5 Stainless Steel Flat Bars: ASTM A666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
- .6 Frame Anchors: Same type as door face.
- .7 Inserts, Bolts and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.
- .8 Furnish inserts and anchoring devices which must be built into other work for installation of access panels.

2.3 **FABRICATION**

- .1 General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- .2 Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names or roughness.
- .3 Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- .4 Latch and Lock Hardware:
 - .1 Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - .2 Keys: Furnish two keys per lock and key all locks alike.
 - .3 Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in Section 08 71 00 - Door Hardware.

2.4 **FINISHES**

- .1 Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- .2 Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- .3 Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- .4 Factory-Primed Finish: Apply manufacturer's standard lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
- .5 Stainless Steel Finishes:
 - .1 Surface Preparation: Remove tool and die marks and stretch lines or blend into finish.
 - .2 Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - .1 Run grain of directional finishes with long dimension of each piece.
 - .2 When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - .3 Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **INSTALLATION**

- .1 Comply with manufacturer's written instructions for installing access doors and frames.
- .2 Installation:
 - .1 locate access doors within view of equipment and ensure equipment is accessible for operating, inspecting, adjusting, servicing without using special tools.
 - .2 Install access doors and panels permitting access to service valves, traps, dampers, cleanouts and other mechanical, electrical and conveyor control items concealed by walls and partitions and concealed above gypsum board and acoustic panel and plaster ceilings.
 - .3 Install fire protection rated access doors and panels in fire rated partitions and ceilings, in accordance with NFPA 80.
 - .4 Isolate steel from direct contact with dissimilar metals, concrete and masonry with isolation coating of alkali-resistant bituminous paint, epoxy or other permanent non-corrosive material recommended by manufacturer.
 - .5 Set frames square and in-plane with the substrate assembly, aligned with adjacent visible finishes. Securely attach to substrates.
 - .6 Access Doors above Acoustic Panel Ceilings: Install unobtrusive identification locators, such as a small self-adhering circle on the acoustic panel.

3.3 **ADJUSTING**

- .1 Adjust access panels to operate easily without binding. Verify that integral locking devices operate properly.
- .2 Remove panels and frames that are warped, bowed or otherwise damaged and replace with new components.
- .3 On completion of access panel installation, clean interior and exterior surfaces as recommended by manufacturer.
- .4 Touch-up with factory-applied finishes if damaged during installation.
- .5 Repair damage to zinc coatings in accordance with ASTM A780/A780M.
- .6 Repair damage to adjacent materials caused by installation of access doors and panels.
- .7 Adjust operable parts for correct function.

3.4 **CLEANING**

- .1 Progress and Final Cleaning: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management and remove gypsum board compound from hinges, frames and door edges.

- .2 Waste Management: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Provide exterior architectural performance class (AW) behavioral care windows.
- .2 Labor, materials, tools, equipment and services needed to furnish and install AW Class windows.
- .3 Components furnished with installed windows.
- .4 Installation accessories furnished and installed.

1.2 **SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS**

- .1 Design Wind Loads - Allowable Stress Design (ASD):
 - .1 Per local building codes.
 - .2 Structural components, including meeting rails, mullions and anchors shall be designed accordingly, complying with deflection and stress requirements as specified herein.
- .2 Air, Water and Structural Performance Requirements:
 - .1 When tested in accordance with cited test procedures, windows shall meet or exceed the following performance criteria, as well as those indicated in AAMA/WDMA/CSA 101/I.S.2/A440-(NAFS) for AW Performance Class windows, Performance Grade 120 (AW120) unless otherwise noted herein:
 - .1 Test units shall not be smaller in either width or height than the "Gateway Test Size" specified in AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS) for AW Performance Class.
 - .2 "Downsize" testing to meet Optional Performance Class requirements specified herein shall not be permitted.
 - .3 Test units shall employ manufacturer's standard sealing, lock spacing and anchorage.
 - .2 Air Test Performance Requirements: Air infiltration maximum 0.1 cfm/ft² at 6.24 psf pressure differential when tested in accordance with ASTM E283.
 - .3 Water Test Performance Requirements: No uncontrolled water leakage at 15 psf static pressure differential, with water application rate of 5 gallons/hr/ft² when tested in accordance with both ASTM E331 and ASTM E547.
 - .4 Structural Test Performance Requirements:
 - .1 Uniform Load Deflection Test: No deflection of unsupported span L of test unit (framing rails, muntins, mullions, etc.) more than L/175 at both a positive and negative load of 120 psf (design test pressure) when tested in accordance with ASTM E330.
 - .2 Uniform Load Structural Test:
 - .1 Unit to be tested at one and one half (1 ½) times design test pressure, both positive and negative, acting normal to plane of wall in accordance with ASTM E330.
 - .2 No glass breakage; permanent damage to fasteners, hardware parts or anchors; damage to make windows inoperable; or permanent deformation of main frame or ventilator member more than 0.2% of its clear span.

- .5 Simulated Human Impact Tests:
 - .1 Conduct tests in accordance with AAMA 501.8, to simulate a purposeful shoulder impact from the interior. Test units shall be representative of windows on the Project in details of frame connections, glazing and anchorage.
 - .2 Test units shall be representative of the largest unit on the Project (both width and height) or 4'-0" x 6'-0", whichever is greater.
 - .3 Meeting rails and mullions to be used on the Project shall be incorporated in test units and similarly tested at maximum and minimum unsupported span.
 - .4 Interior of each test unit shall be impacted with a heavy shot bag swung from a vertical height sufficient to generate 2000 ft-lb of impact, directed at the locations specified in AAMA 501.8. Center-of-glass impact shall be repeated if plies break upon impact.
 - .5 At the conclusion of impact testing, the window shall remain intact as a barrier to egress and meet the performance requirements of AAMA 501.8.
- .3 Life Cycle Testing:
 - .1 When tested in accordance with AAMA 910, there is to be no damage to fasteners, hardware parts, support arms, activating mechanisms or other damage that would cause the window to be inoperable at the conclusion of testing.
 - .2 Air infiltration and water resistance tests shall meet the primary performance requirements specified after completion of cycling.
- .4 Condensation Resistance and Thermal Transmittance Performance Requirements:
 - .1 Perform thermal tests in accordance with National Fenestration Rating Council (NFRC) and/or American Architectural Manufacturers Association (AAMA) test methods or provide finite element computer thermal modeling and calculations per NFRC, AAMA and/or manufacturer's proprietary software as deemed acceptable by the design team. To help ensure proper interpretation, representations of thermal and solar-optical performance shall be qualified explicitly for the glass type, size, configuration, installation accessories and substrate conditions used in their determination.
- .5 Acoustic Performance Requirements:
 - .1 Perform acoustical tests in accordance with ASTM E90 and ASTM E1425 on the glass type(s) specified in Section 08 80 00 - Glazing, rigidly supported in aluminum framing of the same product type.
 - .2 "Glass-only" test results shall not be acceptable.
 - .3 Sound Transmission Class (STC) shall not be less than 47.
- 1.3 **ADMINISTRATIVE REQUIREMENTS**
 - .1 Section 01 31 00 - Project Managing and Coordination: Project management and coordination procedures.
 - .2 Pre-Installation Meeting: Convene [one (1) week] before starting Work of this section.
- 1.4 **SUBMITTALS FOR REVIEW**
 - .1 Section 01 33 00 - Submittal Procedures: Submission procedures.

- .2 Product Data: Provide component dimensions, anchorage and fasteners, glass and internal drainage details.
- .3 Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related work and installation requirements.
- .4 Samples:
 - .1 Submit two (2) samples 1'-0" x 1'-0" in size illustrating window frame section mullion section, screen and frame, factory finished aluminum surfaces, glass and glazing materials.
 - .2 Submit two (2) samples of operating hardware.
- 1.5 **SUBMITTALS FOR INFORMATION**
 - .1 Section 01 33 00 - Submittal Procedures: Submission procedures.
 - .2 Manufacturer's Certificate: Certify that Products meet or exceed **specified requirements** and **performance criteria tests**.
- 1.6 **CLOSEOUT SUBMITTALS**
 - .1 Section 01 78 10 - Closeout Submittals: Submission procedures.
- 1.7 **QUALITY ASSURANCE**
 - .1 Products of this Section: Manufactured to [ISO 9000 and ISO 14000] certification requirements.
 - .2 Comply with CSA-A440S1].
 - .3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified herein with minimum [ten (10)] years [documented] experience.
 - .4 Installer Qualifications: Company specializing in performing the Work of this section with minimum [five (5)] years documented experience [and approved by the manufacturer].
 - .5 In-Plant Testing:
 - .1 Conduct detailed quality audits and ASTM E331 static water infiltration testing on a statistically valid sample of factory-glazed windows prior to shipping, subject to reasonable unit size restrictions.
 - .2 Each tested unit shall be identified with a removable sticker on the inside glass face.
 - .3 Provide detailed documentation of in-plant testing upon request.
- 1.8 **DELIVERY, STORAGE AND PROTECTION**
 - .1 Section 01 61 00 - Product Requirements: Transport, handle, store and protect Products.
 - .2 Protect factory finished aluminum surfaces with [strippable coating and wrapping]. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.
 - .3 Materials will be packed, loaded, shipped, unloaded, stored and protected in accordance with AAMA CW-10.

1.9 **SITE CONDITIONS**

- .1 Ambient Conditions:
 - .1 Do not install sealants when ambient temperature is less than **5°C**.
 - .2 Maintain this minimum temperature during and after installation of sealants.

1.10 **WARRANTY**

- .1 Section 01 78 10 - Closeout Submittals: Warranties.
- .2 Correct defective Work within a [five (5)] year period after Date of Substantial Completion.
- .3 Provide [five (5)] year manufacturer warranty for insulated glass units from seal failure, interpane dusting or misting and replacement of same.
- .4 Warranty:
 - .1 Include coverage for degradation of colour finish.
 - .2 Products: Submit a written warranty, executed by the window manufacturer, for a period of ten (10) years from the date of manufacture, against defective materials or workmanship, including substantial non-compliance with applicable specification requirements and industry standards, which result in premature failure of the windows, finish, factory-glazed glass or parts, outside of normal wear.
 - .3 In the event that windows or components are found defective, manufacturer will repair or provide replacement material without charge at manufacturer's option.
 - .4 Warranty for components must be direct from the manufacturer (non-pass-through) and non-pro-rated for the entire term. Warranty must be assignable to the non-residential owner and transferable to subsequent owners through its length.

Part 2 Products

2.1 **MANUFACTURER**

- .1 Basis of Design: "4000i-DT Series Behavioral Care Fixed and/or In-Swing Casement Windows", as indicated on the Drawings and as manufactured by Wausau Window and Wall Systems <http://www.wausauwindow.com>.
- .2 Substitutions: Not permitted.

2.2 **MATERIALS**

- .1 Aluminum Framing Members
 - .1 Extruded aluminum billet, 6063-T5 or T6 alloy for primary non-radius components, 6063-T5 or T6, 6005-T5, 6105-T5 or 6061-T6 for anchor components, meeting the requirements of ASTM B221.
 - .2 Aluminum sheet alloy 5005-H32 (for anodic finishing) or alloy 3003-H14 (for painted or unfinished sheet) meeting the requirements of ASTM B209.
 - .3 Principal window frame and sash ventilator members will be a minimum 1/8" in thickness at glazing legs, hardware mounting webs and section flanges.
 - .4 Extruded aluminum security glazing stops will be a minimum 1/8" in thickness.
 - .5 Extruded or formed trim components will be a minimum 0.06" in thickness.

- .6 Perimeter frame depth 4" minimum.
- .7 Sash ventilator and fixed lite access panel sections must be tubular and overlap framing members:
 - .1 Vented areas shall be indistinguishable in sightline from fixed areas from the exterior, with vents in the closed position.
 - .2 Sash ventilator joinery shall not be exposed to the exterior with vents in the closed position.
 - .3 Sash ventilator edges shall be filleted.
- .8 Exterior sightlines at perimeter framing members will not exceed 3 ½ " unless detailed otherwise on the Drawings.

2.3 COMPONENTS

- .1 Steel Components:
 - .1 Provide steel reinforcements as necessary to meet the performance requirements as specified herein.
 - .2 Concealed steel anchors and reinforcing shall be factory painted after fabrication with TGIC powder coating or rust-inhibitive primer complying with Federal Specification TT-P-645B.
- .2 Panning:
 - .1 Provide extruded aluminum panning to receive replacement windows as shown on the Drawings.
 - .2 Panning shall be pre-assembled and joinery back sealed prior to installation.
 - .3 Finish to match window frames.
- .3 Receptors:
 - .1 Provide extruded aluminum receptors to receive windows, as shown on the Drawings.
 - .2 Finish to match window frames.
 - .3 If provided, receptors must be tested to the performance requirements and structural calculations specified herein.
- .4 Dual or Triple Glazed Access Panel:
 - .1 Hinged access panel shall be constructed with mitered corners, mechanically staked over a solid aluminum corner block.
 - .2 Provide a hook latch for custodial operation.
 - .3 Finish to match window frames.
- .5 Integral Venetian Blinds:
 - .1 5/8" or 1" wide aluminum slat blinds. Blind color shall be as selected by the Consultant from the manufacturers standard range.
 - .2 Blind to be integrally mounted between the dual or triple glazing.
 - .3 Behavioral care tilt-control knob will be located on the interior face and incorporate a "slip clutch" feature.

- .4 Raise and lower pull cords will be located between glass for access only when glazed access panel is opened.

2.4 GLASS AND GLAZING MATERIALS

- .1 Glass and Security Glazing Infill Material:
 - .1 Provide in accordance with Section 08 80 00 - Glazing.
 - .2 Sealed insulating glass shall be tested and certified in accord with ASTM E2190.
 - .3 Interior security glazing infill material to be in accordance with Section 08 80 00 - Glazing.
- .2 Glazing:
 - .1 Provide in general accordance with Section 08 80 00 - Glazing.
 - .2 Glazing method shall be in general accordance with the Glass Association of North American (GANA) Glazing Manual for specified glass type or as approved by the glass fabricator.
 - .3 Glazing stops retaining security glazing shall be secured at 1'-0" on center using ¼"-20 plated or stainless-steel thread-rolling fasteners.
 - .4 Glazing materials at the interior must be rendered tamper-resistant by a continuous extruded hood projection or other tested and approved method.
 - .5 Provide minimum glazing "bite" as recommended by the security glazing infill fabricator and tested as specified herein.
 - .6 Provide windows factory-glazed wherever practical.
- .3 Glazing Materials
 - .1 Setting Blocks/Edge Blocking: Provide in sizes and locations recommended by GANA Glazing Manual. Setting blocks used in conjunction with soft-coat Low-E glass shall be silicone.
 - .2 Back-bedding tapes, expanded cellular glazing tapes, toe beads, heel beads and cap beads shall meet the requirements of applicable specifications cited in AAMA 800.
 - .3 Glazing gaskets shall be non-shrinking, weather-resistant and compatible with materials in contact.
 - .4 Structural silicone sealant where used shall meet the requirements of ASTM C1184.
 - .5 Spacer tape in continuous contact with structural silicone shall be tested for compatibility and approved by the sealant manufacturer for intended application.
 - .6 Gaskets in continuous contact with structural silicone shall be extruded silicone or compatible material.

2.5 SEALANT MATERIALS

- .1 Sealant and Backing Materials: As specified in Section 07 92 00 - Joint Sealants of types described herein.
- .2 Sealants shall comply with applicable provisions of AAMA 800 and/or Federal Specifications FS-TT-001 and 002 Series.

- .3 Frame joinery sealants shall be suitable for application specified and as tested and approved by window manufacturer.

2.6 **HARDWARE**

- .1 Except as noted, comply with the requirements of [BHMA A156.18].
- .2 Hardware (select from options as noted):
 - .1 Steel components including attachment fasteners to be 300 Series stainless steel except as noted.
 - .2 Extruded aluminum components 6063-T5 or -T6.
 - .3 Locking handles, bases and strikes to be aluminum, die cast, white bronze or stainless steel in manufacturer's standard surface finish.
 - .4 Thermo-plastic or thermo-set plastic caps, housings and other components to be injection-molded nylon, extruded PVC or another suitable compound.
 - .5 Hardware to be custodial or supervisory-operated and include appropriate options listed in the WAUSAU Hardware Selection Guide.

2.7 **FABRICATION**

- .1 General:
 - .1 Finish, fabricate and shop assemble frame and sash ventilator members into complete windows under the responsibility of one (1) manufacturer.
 - .2 No bolts, screws or fastenings shall impair independent frame movement or bridge the thermal barrier, unless such bridging was also present in thermal test units and thermal models.
 - .3 Fabricate to allow for thermal movement of materials when subjected to a temperature differential from -30°F to +180°F.
- .2 Frames:
 - .1 Miter each perimeter frame corner, then mechanically stake over a solid extruded aluminum corner block or weld; then seal weather tight.
 - .2 Cope and mechanically fasten each intermediate meeting rail, then seal weather tight.
 - .3 Make provisions for continuity of frame joinery seals at extrusion webs.
- .3 Main Sash and Access Sash Ventilators: Miter corners and mechanically stake over a solid extruded aluminum corner block, set and sealed in epoxy.
- .4 Hardware:
 - .1 Concealed Hinges at Sash Ventilator and Fixed Lite Access Panels: Provide two (2) concealed extruded aluminum "walk-around" butt hinges with stainless steel pins. Provide three (3) hinges on in-swing casement units over 4'-0" in height.
 - .2 Locks:
 - .1 Die cast or stainless-steel cam locks, strikes and/or keepers for custodial or supervisory operation shall secure sash in closed position. Refer to WAUSAU Hardware Selection Guide.
 - .2 Provide tamper-resistant locks for ventilators at maximum 4'-0" spacing. Keys shall not be removable in the unlocked position.

- .3 Provide a supplemental keyed GEM lock for interior sash ventilators and access panels.
- .4 Friction Adjuster: Provide concealed device with adjustable friction shoe to arrest sash opening before contact with adjacent materials occurs.
- .5 Limited Opening Device: Provide concealed device to limit initial sash operation to 4". Operation past this point to be by use of a tool or removable key.
- .6 Dual or Triple Glazed Access Panel at Sash Ventilators: Access panel to have a custodial hook latch.
- .5 Dual or Triple Glazed Access Panel: Hinged access panel will be constructed with mitered corners, mechanically staked over a solid aluminum corner block.
- .6 Weatherstripping:
 - .1 Bulb or fin type neoprene, EPDM, dual-durometer PVC, polypropylene, TPE or other suitable material as tested and approved by the window manufacturer.
 - .2 Miter, crowd, stake or join at corners. Provide drainage to exterior as necessary.
 - .3 Provide weather-strip at access panels for minimum thermal separation of ¼ ".
 - .4 Weatherstripping shall provide an effective pressure-equalization seal at the interior face of the sash ventilator.

2.8

FINISHES

- .1 Finish of exposed areas of aluminum windows and components shall be done in accordance with the appropriate AAMA Voluntary Guide Specification shown:

DESIGNATION	DESCRIPTION	STANDARD	COLOR
AAM10C21A41	Clear Class I Eco-friendly etch	AAMA 611	Clear
AAM10C21A44	Electrolytically	AAMA 611	Champagne, Light Bronze, Medium Bronze
	Deposited Class I		Dark Bronze, Extra Dark Bronze, Black
	Eco-friendly etch		Copper Anodize
Interior Paint	50% PVDF	AAMA 2603	As selected by the Consultant
	Enamel, Acrylic or Polyester (suitable for interior applications)		As selected by the Consultant
Exterior Paint	70% PVDF	AAMA 2605	As selected by the Consultant

- .2 Operator and Exposed Hardware: Enameled to colour as selected.
- .3 Shop and Touch-Up Primer for Steel Components: SSPC-Paint 25, zinc oxide alkyd.
- .4 Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, Type I - Inorganic zinc-rich primer.
- .5 Concealed Steel Items: Hot-dip galvanized to appropriate grade for type and size of steel material indicated, coating thickness ASTM A123/A123M.

- .6 Concealed Steel Items: Primed with iron oxide paint.
- .7 Apply one (1) coat of bituminous paint to concealed aluminum and/or steel surfaces in contact with cementitious or dissimilar materials.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Verify wall openings and adjoining air and vapour seal materials are ready to receive Work of this section.
- .3 Site Verification of Conditions:
 - .1 Verify that building substrates permit installation of windows according to the manufacturer's instructions, approved Shop Drawings, calculations and Contract Documents.
 - .2 Do not install windows until unsatisfactory conditions are corrected.

3.2 **INSTALLATION**

- .1 Install window frames, glazing and hardware to manufacturer's written instructions.
- .2 Install window assembly to CAN/CSA-A440.4.
- .3 Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- .4 Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- .5 Install sill and sill end angles.
- .6 Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- .7 Coordinate attachment and seal of perimeter air barrier and vapour retarder materials.
- .8 Install operating hardware.
- .9 Install glass and infill panels as specified in Section 08 80 00 - Glazing, to glazing method required to achieve performance criteria.
- .10 Install perimeter sealant to method required to achieve performance criteria.
- .11 Erection of Aluminum Windows:
 - .1 Install windows with skilled workers in accordance with approved Shop Drawings, installation instructions, specifications and the AAMA Commercial Window and Door Installation Manual.
 - .2 Windows must be installed and remain, plumb, square and level, to one-half (½) of the unit shimming tolerances cited in the AAMA Commercial Window and Door Installation Manual, for proper weathering and operation. Installer to make necessary final hardware adjustments on the Project site.
 - .3 Aluminum that is not organically coated shall be insulated from direct contact with steel, masonry, concrete or other dissimilar metals by bituminous paint, rust-inhibiting primer, non-conductive shims or other suitable insulating material.

3.3 ERECTION TOLERANCES

- .1 Section 01 73 00 - Execution: Tolerances.
- .2 Material and Unit Size Tolerances: As specified in AAMA/WDMA/CSA 101/I.S.2/A440.

3.4 ADJUSTING

- .1 Adjust hardware for smooth operation and secure weathertight closure.

3.5 CLEANING

- .1 Section 01 74 00 - Cleaning and Waste Processing: Cleaning installed work.
- .2 Remove protective material from factory finished aluminum surfaces.
- .3 Wash surfaces by method recommended and acceptable to sealant and window manufacturer, rinse and wipe surfaces clean.
- .4 Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.

END OF SECTION

SECTION 087100 – DOOR HARDWARE

PART 1- GENERAL

1.1 SUMMARY

- A. Section Includes: Door hardware for wood doors, steel doors, aluminum framed entrance doors, all glass entrance doors, and miscellaneous hardware items.
- B. Provide hardware not described herein but otherwise required for proper completion of the project, conforming to size, function, quality, and finish of other specified hardware.

1.2 REFERENCED STANDARDS

- A. American National Standards Institute (ANSI):
 - 1. ANSI A117.1 Accessible and Usable Buildings and Facilities
- B. Builders Hardware Manufacturers Association (BHMA):
 - 1. ANSI/BHMA A156.1 Butts and Hinges.
 - 2. ANSI/BHMA A156.3 Exit Devices.
 - 3. ANSI/BHMA A156.4 Door Controls - Closers.
 - 4. ANSI/BHMA A156.5 Auxiliary Locks and Associated Products.
 - 5. ANSI/BHMA A156.6 Architectural Door Trim.
 - 6. ANSI/BHMA A156.7 Template Hinge Dimensions.
 - 7. ANSI/BHMA A156.8 Door Controls - Overhead Stops and Holders.
 - 8. ANSI/BHMA A156.10 Power Operated Pedestrian Doors.
 - 9. ANSI/BHMA A156.13 Mortise Locks and Latches.
 - 10. ANSI/BHMA A156.15 Release Devices: Closer Holders, Electromagnetic and Electromechanical.
 - 11. ANSI/BHMA A156.16 Auxiliary Hardware.
 - 12. ANSI/BHMA A156.17 Self-Closing Hinges and Pivots.
 - 13. ANSI/BHMA A156.18 Materials & Finishes.
 - 14. ANSI/BHMA A156.19 Power Assist & Low Energy Power Operated Doors.
 - 15. ANSI/BHMA A156.21 Thresholds.
 - 16. ANSI/BHMA A156.22 Door Gasketing and Edge Seal Systems.
 - 17. ANSI/BHMA A156.23 Electromagnetic Locks.
 - 18. ANSI/BHMA A156.24 Delayed Egress Locks.
 - 19. ANSI/BHMA A156.25 Electrified Locking Devices.
 - 20. ANSI/BHMA A156.26 Continuous Hinges.
 - 21. ANSI/BHMA A156.28 Recommended Practices for Mechanical Keying Systems.
 - 22. ANSI/BHMA A156.29 Exit Locks, Exit Locks with Exit Alarms, Exit Alarms, Alarms for Exit.
 - 23. ANSI/BHMA A156.30 High Security Cylinders.
 - 24. ANSI/BHMA A156.31 Electrified Strikes and Frame Mounted Activators.
 - 25. ANSI/BHMA A156.115 Hardware Preparation in Steel Doors with Steel Frames.
 - 26. ANSI/BHMA A156.115W Hardware Preparation in Wood Doors with Wood or Steel Frames.
- C. Door and Hardware Institute (DHI):
 - 1. ANSI/DHI A115.IG Installation Guide for Doors and Hardware
 - 2. DHI Keying Systems and Nomenclature
 - 3. DHI Sequence and Format for the Hardware Schedule
- D. International Building Code (IBC)

- E. National Fire Protection Association (NFPA):
 - 1. NFPA 80 Fire Doors and Fire Windows
 - 2. NFPA 252 Fire Tests of Door Assemblies
- F. Underwriters Laboratories Inc. (UL):
 - 1. UL 10C Positive Pressure Fire Tests Of Door Assemblies
 - 2. UL 305 Panic Hardware
 - 3. UL 437 Drill and Pick Resistant Key Cylinders
 - 4. UL 1034 Burglary-Resistant Electric Locking Mechanisms

1.3 SUBMITTALS

- A. Products other than those designated herein must be approved as substitutions prior to submittal of Door Hardware.
- B. Door Hardware Schedule: Vertical format conforming to DHI "Sequence and Format for the Hardware Schedule." Horizontal format schedules will be rejected without review. Format shall be 8-1/2 by 11 inch page size. Organize Schedule into headings, grouping doors to receive same hardware items, indicating quantity and complete designations of every item required for each door opening. The schedule shall include:
 - 1. Cover sheet indicating name and location of Project; name of Architect; name of Contractor; name, address and phone of hardware supplier, name of hardware consultant preparing the schedule; date of submittal or revised submittal.
 - 2. A list of abbreviations used in schedule.
 - 3. An index of door openings, listed in numerical order, with hardware heading identification cross-referenced to Architect's set identification.
 - 4. Hardware headings shall be listed in numerical order corresponding, as closely as possible, with numerical order of Architect's set numbers.
 - 5. Each hardware heading shall have each door listed in numerical order according to door numbers in the Architect's door schedule, and denoting: location, configuration (single, pair, etc.), type (elevation, etc.), door and frame size(s), door and frame material(s), handing, fire rating, and key set identification.
 - 6. Type, complete model number, style, function, size, hand, and finish of each door hardware item.
 - 7. Manufacturer of each item.
 - 8. Fastenings and other pertinent information.
- C. Manufacturer's Technical Product Data / Catalog Cut Sheets: Clearly marked for each hardware item, including installation details, material descriptions, dimensions of individual components and profiles, and finishes. Format shall be 8-1/2 by 11 inch page size.
- D. Wiring Diagrams: No later than 14 days after receipt of reviewed hardware schedule submittal, submit detailed wiring diagrams for power, signaling, monitoring, and control of the access control system electrified hardware or other system electrified components such as sensors, switches, or indicator/ strobe lights; identified by door number(s), and detailed specifically for each type and function of electrified door opening. Format shall be 8-1/2 by 11 inch page size. Include the following:
 - 1. System Description of Operation. Include description of component functions including, but not limited to, the following situations: normal secured/unsecured state of door; authorized access; authorized egress; unauthorized access; unauthorized egress; fire alarm and loss of power conditions, and interfaces with other building control systems.
 - 2. Elevation single-line diagram, showing interface between electrified door hardware and fire alarm, power, access control, and security systems as applicable.
 - 3. Point-to-point wiring diagram for field-installed wiring.

- E. Keying Schedule: In accordance with Owner's final keying instructions for locks. Conform to DHI "Keying Systems and Nomenclature." Format shall be 8-1/2 by 11 inch page size.
- F. Operation and Maintenance Data: Provide complete operating and maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- H. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
- B. Manufacturers, Hardware Supplier, and Installer shall have no less than five years' experience in the provision of Door Hardware for projects similar in size, complexity and type to this Project.
- C. Hardware Schedule and Keying Schedule submittals shall be prepared by a Hardware Consultant holding the credentials of Architectural Hardware Consultant (AHC) issued by the Door and Hardware Institute. Hardware Consultant shall have no less than five years' experience in the scheduling of Door Hardware for projects similar in size, complexity and type to this Project; and shall be available, at no additional cost, during the course of the Work to consult with Contractor, Architect, and Owner regarding door hardware and keying.

1.5 REGULATORY REQUIREMENTS

- A. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with all applicable regulations, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. At rated doors with panic exit devices, provide devices labeled as "Fire Exit Device."
- B. Comply with all applicable accessibility regulations as set forth in Americans with Disabilities Act (ADA) -- Accessibility Guidelines for Buildings and Facilities (ADAAG) and ANSI A117.1. 2010 Standards for Accessible Design as applicable.
- C. Latching and locking doors that are hand-activated and that are in a path of travel shall be operable with a single effort by lever-type hardware, panic bars, push-pull activating bars, or other hardware designed to be easy to grasp with one hand, not requiring tight grasping, tight pinching or twisting of the wrist; from egress side shall not require the use of a key, tool, or special knowledge for operation.
 - 1. All hand-activated hardware shall be mounted between 34 inches and 48 inches above finished floor.
- D. At sliding doors, when fully open, operating hardware shall be exposed and usable from both sides.
- E. Door closing devices shall comply with the following maximum opening-force requirements:
 - 1. Interior Hinged Doors: 5 lbf applied perpendicular to door at latch.
 - 2. Exterior Hinged Doors: 5 lbf applied perpendicular to door at latch.
 - 3. Sliding or Folding Doors: 5 lbf applied parallel to door at latch.

- 4. Fire Rated Doors: 5 lbf applied perpendicular to door at latch. To insure latching, may be increased to the minimum force allowable by the appropriate administrative authority, not to exceed 15 lbf.
- F. Where door closers are provided, adjust sweep speed so that from an open position of 90 degrees, the time required to move the door to a position of 12 degrees from the latch is 5 seconds minimum.
- G. Thresholds shall be maximum 1/2 inch in height above floor and landing on both sides of openings. Bevel raised thresholds with a slope of not more than 1:2.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Each article of hardware shall be delivered individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule.
- B. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.
- C. Hardware shall be stored in a dry, secure locked area, complete with shelving for unpacking and sorting of the door hardware.
- D. Deliver all master keys by restricted, receipted delivery directly from the manufacturer to the Owner.

1.7 COORDINATION

- A. Provide hardware templates to the parties involved for doors, frames, and other work specified to be factory prepared for door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. When required by door or frame fabricator, furnish physical samples of each mortised and recessed hardware item required.
- C. Coordinate layout and installation of recessed pivots and closers with floor construction.
- D. Electrical System Rough-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, and security system as applicable.
- E. Pre-Installation Conference: Arrange conference at job site to coordinate door, frame, hardware and electronic security hardware installation; to be attended by the Architect, Owner, Contractor and representative personnel of firms involved in the provision and installation of said items.
- F. Keying Conference: Arrange conference with Owner, or designated representative, and Manufacturer's/ Hardware Supplier's Architectural Hardware Consultant to establish keying requirements. Incorporate keying conference decisions into Keying Schedule.

1.8 WARRANTY

- A. In addition to, and not precluding, other warranty requirements in the Contract Documents, the following hardware items shall carry extended minimum warranties as indicated:

1. Hinges: Ten years from date of Substantial Completion.
2. Locks: Five years from date of Substantial Completion.
3. Exit Devices: Three years from date of Substantial Completion.
4. Door Closers: Ten years from date of Substantial Completion.

1.9 MAINTENANCE

- A. Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements herein, provide products by one of the following manufacturers for each type of hardware:
 1. Butt Hinges: McKinney
 2. Continuous Pinned Hinges: Architectural Builders Hardware
 3. Continuous Geared Hinges: Architectural Builders Hardware.
 4. Pivots: Architectural Builders Hardware.
 5. Cylinders and Keying: Per Owner's Requirements.
 6. Locksets and Latchsets: Sargent, Townsteel
 7. Exit Devices: Sargent.
 8. Electric Strikes: Deltrex USA, Folger Adam, Hanchett Entry Systems (HES), Rutherford Controls Intl. (RCI), Von Duprin.
 9. Electromagnetic Lock Assemblies: Deltrex, Schlage, Securitron.
 10. Electrical Power Transfers: Architectural Builders Hardware, Securitron, Von Duprin.
 11. Flush Bolts and Door Coordinators: Architectural Builders Hardware, Ives, Rockwood.
 12. Surface Door Closers: LCN 4040XP, 4210T/4510T Series, Norton 9500 Series, Sargent 281 Series.
 13. Overhead Holders and Stops: Architectural Builders Hardware, Glynn-Johnson, Rixson.
 14. Architectural Door Trim: Architectural Builders Hardware, Ives, Rockwood, Trimco.
 15. Auxiliary Hardware: Ives, Rockwood, Trimco.
 16. Door Bottoms, Metal Thresholds, Weatherstripping and Gaskets: National Guard Products, Pemko, Zero.
 17. Key Storage System: Lund, MMF Industries, Telkee.

2.2 MATERIALS AND FABRICATION

- A. Requirements for grade, materials, size, and other distinctive qualities of each type of door hardware are indicated herein. Furnish items in types, sizes or weight, in accordance with manufacturer's standards, appropriate for the conditions of installation and service, unless otherwise indicated.
- B. Products named or identified by make or model number, or other designation and described herein are base products. Base products establish the standards of type, in-service performance, physical properties, appearance, warranty, cost, and other characteristics required by the Project.

2.3 FASTENERS

- A. Provide concealed fasteners for hardware items on exterior doors which are exposed when door is closed.

- B. Combination machine screws and expansion shields shall be used for attaching hardware to concrete or masonry.
- C. Fasteners exposed to the weather in the finished work shall be of brass, bronze, or stainless steel.

2.4 BUTT HINGES

- A. Butt hinges shall meet the requirements of ANSI/BHMA A156.1.
- B. Hinge dimensions shall meet the requirements of ANSI/BHMA A156.7.
- C. Base Metal shall be steel plated for fire-rated doors; bronze or stainless steel for exterior out swinging doors; bronze or plated steel elsewhere as scheduled.
- D. Provide hinges with antifriction bearings for doors with closers.
- E. Unless otherwise indicated, provide hinges in heights and weights as follows:
 - 1. Doors to 36 inches wide: 4-1/2 inches Standard Weight.
 - 2. Doors over 36 inches to 48 inches wide: 5 inches Heavy Weight.
 - 3. Doors over 48 inches wide: 6 inches Heavy Weight.
 - 4. Doors over 1-3/4 inch thick shall be per hinge manufacturers published listings or recommendations.
- F. Provide in minimum width sufficient to clear trim when door swings 180 degrees, whether or not shown on Drawings to swing 180 degrees.
- G. Number of hinges per leaf shall be as follows:
 - 1. Doors to 60 inches in height: 2 hinges.
 - 2. Doors over 60 to 90 inches in height: 3 hinges.
 - 3. Doors over 90 to 120 inches in height: 4 hinges.
 - 4. For doors over 120 inches in height: 4 hinges plus 1 hinge for every 30 inches, or fraction thereof, door height greater than 120 inches.
- H. Screws: Flat head wood screws not less than 1-1/2 inches long for hinges for wood doors; flat head machine screws elsewhere.
- I. Hinges for reverse bevel doors with locks shall have pins that are made non-removable when the door is in the closed position by means of a set screw in the hinge pin barrel.
- J. Electrified hinges:
 - 1. Coordinate number and size of wires for electrified hardware served.
 - 2. Provide junction box/ mortar shield for each electrified hinge.
- K. Provide hospital tips at ligature resistant openings.

2.5 LIGATURE RESISTANT CONTINUOUS PINNED HINGES

- A. Continuous hinges shall meet ANSI/BHMA A156.26 requirements.
- B. Type: Pin and barrel construction; 1/4 inch diameter stainless steel pin; split nylon or stainless steel bearings. Fabricated from 14 gauge cold-rolled steel or 304 stainless steel as indicated.
- C. Provide in minimum width sufficient to clear trim when door swings 180 degrees, whether or not shown on Drawings to swing 180 degrees.

- D. Hole pattern for fasteners shall be symmetrical and located to template dimensions.
- E. Provide tamper resistant security screws at ligature resistant openings.
- F. Provide hospital tips at ligature resistant openings.

2.6 LIGATURE RESISTANT CONTINUOUS GEARED HINGES

- A. Continuous hinges shall meet ANSI/BHMA A156.26 requirements.
- B. Type: Heavy duty assembly of 3 interlocking aluminum extrusions. Door leaf and jamb leaf shall be continuously geared together the full hinge length; secured together with full length cover channel permitting 180 degree operation. Vertical door loads carried on integrated thrust bearings spaced no more than 3 inches apart.
- C. Hinges shall have non-removable cap at hinge top to prevent foreign material from becoming lodged in hinge gear mechanism.
- D. Unless otherwise noted, provide factory finished to match door and frame finish.
- E. Hole pattern for fasteners shall be symmetrical and located to template dimensions.
- F. Provide tamper resistant security screws at ligature resistant openings.
- G. Provide hospital tips at ligature resistant openings.

2.7 PIVOT HINGES

- A. Pivot hinges shall meet ANSI/BHMA A156.4 Grade 1 requirements.
- B. Pivots shall be constructed of steel, cast or forged bronze, or stainless steel as indicated by BHMA finish specified.
- C. Where offset pivots are used, provide intermediate pivots as follows:
 - 1. Doors over 60 to 90 inches in height provide one intermediate pivot.
 - 2. For doors over 90 inches in height provide one additional intermediate pivot for every 30 inches, or fraction thereof.
- D. Electrified pivots:
 - 1. Coordinate number and size of wires for electrified hardware served.
 - 2. Provide junction box/ mortar shield for each electrified pivot.

2.8 CYLINDERS, KEYING AND KEY STORAGE

- A. Lock cylinders shall meet ANSI/BHMA A156.5 requirements.
- B. Keying system shall meet ANSI/BHMA A156.28 requirements.
- C. All cylinders shall be interchangeable core type.
- D. Cylinders at exit devices shall be interchangeable core type. Provide mortise or rim type cylinders as required by device for all exit devices having key locking function.
- E. Cylinders shall be High-Security type, listed and labeled as complying with drill and pick-resistant testing requirements of UL 437.
- F. Keying shall be provided per the Owner's requirements.

- G. Cylinders shall be keyed according to approved Keying Schedule.
- H. Provide a temporary keying system for interim use during construction.
- I. Provide change keys in individual envelopes for each cylinder delivered. Envelopes shall be marked with respective door identification numbers.
- J. Key set symbol, and inscription "Do Not Duplicate" shall be stamped on all keys.
- K. Key set symbol shall be concealed stamped on all cylinders/ removable/ Interchangeable cores.
- L. Keys shall be supplied as follows:
 - 1. Locks: 3 change keys each lock.
 - 2. Master keyed sets: 2 keys each set.
 - 3. Grand master keys: 5 total.
 - 4. Great Grand master keys: 5 total.
 - 5. Interchangeable Core control keys: 2 total.
 - 6. Construction keys: 10 total.
 - 7. Blank keys: 100 total.
- M. Provide Key Storage / Control System conforming to ANSI/BHMA A156.5, including key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers. Contain system in metal cabinet with baked-enamel finish and key locking door.
 - 1. Key tags and holders shall be inscribed with key-change number and key-control to conform with approved hardware schedule for identification.
 - 2. Key Storage System shall be large enough to accommodate 150 percent of the facility.

2.9 LOCKSETS AND LATCHSETS

- A. Mortise Locks and Latches shall meet ANSI/BHMA A156.13 Grade 1 requirements.
- B. Auxiliary Locks shall meet ANSI/BHMA A156.5 requirements.
- C. Electrified Locks shall also meet ANSI/BHMA A156.25 requirements.
- D. Operating trim shall be lever type: Refer to hardware sets.
- E. Lock functions which include thumb turn trim shall be provided with thumb turns compliant with accessibility code requirements.
- F. Lock Throw: Comply with requirements for length of latch bolts to comply with labeled fire door requirements.
- G. Lock backset shall be 2-3/4 inches unless otherwise indicated.
- H. ADA Thumb-turns shall be used on all locksets requiring thumb-turns, similar to Accurate Lock and Hardware ADA Turn, Corbin Russwin Ergonomic or Schlage L583-363 EZ-Turn.
- I. Electromechanical locksets utilized at fire rated openings shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction, and shall maintain door in positive latched position when power is off.

- J. Narrow backset locksets to be used when standard width/ backset devices do not fit door stile.

2.10 LIGATURE RESISTANT LOCKSETS

- A. All ligature resistant locksets to be equipped with behavioral health trim.
- B. Provide tamper resistant security screws.
- C. All locks to be furnished with functions as indicated in hardware sets.
- D. Furnish cylinders for all locking functions. Where institutional locks are listed, provide two cylinders for each lockset.

2.11 EXIT DEVICES

- A. Exit devices and exit device accessories shall meet ANSI/BHMA A156.3, Grade 1 requirements.
- B. Electromechanical exit devices shall also meet ANSI/BHMA A156.25 requirements.
- C. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
- D. Fire Exit Devices: Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
- E. Outside Trim: Design, material and finish to match locksets, unless otherwise indicated.
- F. Adjustable strikes shall be provided for rim type and vertical rod devices.
- G. Fire Exit Removable Mullions: Where indicated, provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.
- H. Electromechanical exit devices utilized at fire rated openings shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction, and shall maintain door(s) in positive latched position when power is off.
- I. Narrow backset devices shall be provided to match specified device when standard width chassis/ devices do not fit door stile.
- J. Provide flush end caps at exit devices.
- K. Provided 31- or similar where door thickness is greater than 1.75 inches.
- L. Provide flush end cap (43-, PA-) at all exit devices.

2.12 ELECTRIC STRIKES

- A. Electric strikes shall meet ANSI/BHMA A156.31 Grade 1 requirements, and be listed and labeled under UL 1034 Burglary Resistant Electric Locking Equipment.
- B. Electric strikes for fire rated openings shall be listed and labeled for such use by a testing agency acceptable to authorities having jurisdiction. Fail Secure (fail locked) strikes shall be used at all fire rated openings.

2.13 ELECTROMAGNETIC LOCK ASSEMBLIES

- A. Electromagnetic lock assemblies shall meet ANSI/BHMA A156.23 Grade 1 requirements.
- B. Locks shall be field-selectable for 12 or 24 VDC operation, and provide 1,500 lbf minimum holding force for direct pull applications and 2,000 lbf holding force for shear type applications.
- C. Wiring connections shall be via on-board screw terminal connections. Lock shall have built-in circuit/ surge and voltage kickback suppression protection.
- D. Where indicated, locks shall be equipped with concealed sensors to monitor magnetic bond status and door position status.
- E. Locks used on fire rated doors shall be listed and labeled for such use by a testing agency acceptable to authorities having jurisdiction.

2.14 FLUSH BOLTS

- A. Automatic flush bolts shall meet ANSI/BHMA A156.3
- B. Manual flush bolts shall meet BHMA A156.16 requirements.
 - 1. Bottom bolt shall have 12 inch long operating rod. Top bolt operating rod shall be determined by door height, assuring the operator is located less than 72 inches above the floor.
 - 2. Manual Flush Bolts are not to be utilized except where a pair of non-rated doors serving a room not normally occupied is needed for the movement of equipment.
- C. Provide dust proof strikes for bottom bolts. Dust proof strikes shall meet BHMA A156.16.

2.15 DOOR COORDINATORS

- A. Door coordinators shall meet ANSI/BHMA A156.3 requirements.
- B. Door coordinators shall be flat bar type; stop mounted with all necessary filler bars and mounting brackets to accommodate required hardware.
- C. Provide carry bar at each pair of doors equipped with an overlapping astragal, except when automatic or self-latching bolts are used.

2.16 SURFACE DOOR CLOSERS

- A. Door closing devices shall meet ANSI/BHMA A156.4, Grade 1 requirements.
- B. Surface closers shall be fully adjustable with sweep speed, latch speed and back check position valves.

- C. Provide closers size adjusted in accordance with ANSI/BHMA A156.4; sized as required to insure closing and latching of doors.
- D. Arm selection shall follow the requirements of the manufacturer's recommendations with brackets, drop plates and miscellaneous accessories provided as necessary.
- E. Provide closers with arms designed to permit openings of doors as far as job conditions will permit; unless otherwise indicated closers with arms restricting opening of door will not be acceptable.

2.17 OVERHEAD CONCEALED DOOR CLOSERS

- A. Overhead Concealed Door Closers shall meet ANSI/BHMA A156.4 requirements.
- B. Closers shall be fully adjustable with sweep speed, latch speed and back check position valves.
- C. Provide closers size adjusted in accordance with ANSI/BHMA A156.4; sized as required to insure closing and latching of doors.

2.18 OVERHEAD HOLDERS AND STOPS

- A. Overhead holders and stops shall meet ANSI/BHMA A156.8 requirements.
- B. Overhead door holders and stops shall be adjustable from 90 to 110 degrees dead stop or hold open position, as applicable.
- C. Overhead door stops shall have shock absorbers providing 5 to 7 degrees compression before dead stop.
- D. Overhead stops shall not be provided with hold open function when used at fire rated doors.

2.19 ELECTROMAGNETIC HOLDER / RELEASES

- A. Electromagnetic holders shall meet ANSI/BHMA A156.15 requirements.
- B. Size and configuration shall provide degree of swing and hold open position as indicated on the drawings.

2.20 ARCHITECTURAL DOOR TRIM

- A. Architectural door trim shall meet ANSI/BHMA A156.6 requirements.
- B. Door Protection Plates: Kick, mop, and armor plates shall be 0.050 inch thick brass, bronze, or stainless steel depending on finish indicated. Plates shall have beveled edges, and shall be provided with countersunk mounting holes and No. 6 oval head screw fasteners. Width of kick and armor plates shall be 2 inches less than door width for single doors and 1 inch less for pairs of doors. Width of mop plates shall be 1 inch less than door width. Unless otherwise indicated, height shall be 10 inches for kick and mop plates, and 34 inches for armor plates.
 - 1. At fire rated doors, provide UL labeled protection plates in sizes, types, fasteners and materials only in accordance with door manufacturer's listings for respective ratings.

- C. Door Edging and Astragals: Fabricated from 18 gauge cold-rolled steel or 304 stainless steel as indicated; factory prepared for all mortise hardware; countersunk screw mounting.
 - 1. At fire rated doors, provide UL labeled edge protection in sizes, types, fasteners and materials only in accordance with door manufacturer's listings for respective ratings.
- D. Push and pull plates shall be 0.050 inch thick brass, bronze, or stainless steel depending on finish indicated. Plates shall have beveled edges, and shall be furnished with countersunk mounting holes and No. 6 oval head screw fasteners. Pull plates shall also be furnished with flat-head through bolts for pull grip.
- E. Push and pull bars and grip handles shall be brass, bronze, or stainless steel depending on BHMA finish indicated.

2.21 AUXILIARY HARDWARE

- A. Auxiliary hardware shall meet ANSI/BHMA A156.16 requirements.
- B. Door Stops: Stops shall be of heavy duty construction, provided in finish indicated. Wall bumpers shall have no visible fasteners. Floor stops shall be of height required by floor conditions.
- C. Silencers: Gray rubber, non-marring configured for metal or wood frames as scheduled. Provide 3 per single door and 2 per pair of doors. Silencers shall be tamper resistant once installed in door frame.

2.22 ELECTRICAL POWER TRANSFERS

- A. Electrical power transfers shall be capable of transferring sufficient electrical current to properly operate electrified hardware in door.
- B. Electrical power transfers used on fire rated doors shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

2.23 ELECTRIFIED ACCESSORIES

- A. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
 - 1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK)
- Electrical Connecting Kit: QC-R001.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK)
- Connector Hand Tool: QC-R003.
 - 2. Manufacturers:
 - a. Hager Companies (HA) - Quick Connect.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK)
- QC-C Series.

- c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK)
– PoE Series.

- B. Request-to-Exit Motion Sensor: Request-to-Exit Sensors motion detectors specifically designed for detecting exiting through a door from the secure area to a non-secure area. Include built-in timers (up to 60 second adjustable timing), door monitor with sounder alert, internal vertical pointability coverage, 12VDC or 24VDC power and selectable relay trigger with fail safe/fail secure modes.

2.24 DOOR BOTTOMS

- A. Door bottoms shall be of aluminum or extruded bronze of the type and finish indicated and shall provide proper clearance and an effective seal with specified thresholds.
- B. Door bottom shall have a vinyl, neoprene, silicone rubber, polyurethane or brush seal as indicated.
- C. The door bottom shall exclude light when the door is in the closed position and shall inhibit the flow of air through the unit.

2.25 METAL THRESHOLDS

- A. Thresholds shall meet ANSI/BHMA A156.21 requirements.
- B. Thresholds shall be heavy-gauge aluminum or bronze of the configuration and finish indicated, and shall provide an effective seal with door bottom.
- C. Where required, thresholds shall be prepared to accommodate floor closers, pivots, and projecting bolts of latching hardware.
- D. Thresholds at floor closers shall have mitered returns and removable access portion for floor closer maintenance.
- E. Provide thresholds at doors where indicated. Refer to Door Schedule and Drawing details for type and configuration required. Additionally, where combustible flooring passes under doors, provide fire door thresholds in accordance with applicable regulatory requirements.

2.26 METAL HOUSED TYPE WEATHERSTRIP

- A. Metal Housed Type Weatherstrip shall meet ANSI/BHMA A156.22 requirements.
- B. Metal Housed Type Weatherstrip shall be aluminum or bronze of the type and finish indicated, comprised of metal retainers with vinyl, neoprene, silicone rubber, polyurethane or brush inserts as indicated.

2.27 GASKETING

- A. Gasketing shall meet ANSI/BHMA A156.22 requirements.
- B. Shall be a compression type product for use with wood or steel doors; labeled for use on smoke-control and fire-rated doors where required.

2.28 FINISHES

- A. Hinges (interior), Stops etc., shall be satin chrome finish (626/US26D).

- B. Hinges (exterior), Locksets, Exit Devices, Cylinder Housings, Pulls, Protection Plates shall be Satin Stainless (630).
- C. Thresholds and Surface Door Bottoms shall be Aluminum.
- D. Closers shall be Powder Coated Aluminum (689).
- E. Adhesive Gasketing shall be Charcoal.

PART 3- EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine rough-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Steel doors shall be factory prepared for hardware per ANSI/BHMA A156.115.
- B. Wood doors shall be factory prepared for hardware per ANSI/BHMA A156.115W.
- C. Installation shall be in accordance with DHI A115.IG.
- D. Hardware for fire door assemblies shall be installed conforming with NFPA 80, and all other applicable building codes and regulations.
- E. Hardware for smoke door assemblies shall be installed conforming with NFPA 105, and all other applicable building codes and regulations.
- F. Install each door hardware item according to manufacturer's printed instructions, utilizing templates and proper fasteners provided by manufacturer.
- G. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
- H. 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, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in other Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

3.3 CONTINUOUS HINGES

- A. Prevent conflicts with other installed hardware mounted in the same location.
- B. Coordinate continuous hinge lengths to prevent conflicts with other door hardware such as door sweeps and door bottoms. Door bottoms shall be installed full width of door to create a full seal.

3.4 DOOR CLOSING DEVICES

- A. Surface closers on doors opening to or from halls and corridors shall be mounted on the room side of the door.
- B. Surface closers on doors opening into stairs or stair vestibules shall be mounted on the stair or stair vestibule side of the door.
- C. Surface closers on exterior doors shall be mounted on the interior side of building utilizing regular arm, or parallel arm mounting as required.
- D. Door closing devices with adjustable spring power shall be adjusted for proper door operation, and compliance with all applicable codes and regulations.
- E. Cutting of gasketing or weatherstripping to accommodate closer installation is not acceptable.

3.5 PUSH-PULL PLATES

- A. Pull plate grip handles shall be through bolted through the door. When push plate is indicated on opposite door side, through bolts shall be countersunk with push plate mounted to conceal through bolts.

3.6 KEY CONTROL STORAGE SYSTEMS

- A. Key control storage system shall be installed where directed by the Architect.
- B. Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.

3.7 GASKETING/ WEATHERSTRIPPING

- A. Prevent conflicts with other installed hardware mounted in the same location.
- B. Coordinate door sweep and door bottom widths to prevent conflicts with other door hardware such as continuous hinges. Door bottoms shall be installed full width of door to create a full seal.

3.8 THRESHOLDS

- A. Thresholds shall be secured with a minimum of 3 fasteners per single door width and 6 fasteners per double door width with a maximum spacing of 12 inches; with a minimum of 1 inch thread engagement into the floor or anchoring device used. Thresholds over 6 inches in width shall be secured with a double row of fasteners.
- B. Exterior thresholds shall be installed in a bed of sealant with combination expansion anchors and stainless steel machine screws, except that bronze or anodized bronze thresholds shall be installed with expansion anchors with brass screws.

3.9 ASTRAGALS

- A. Unless otherwise indicated install overlapping astragals as follows:
 - 1. At out-swing pairs of doors, mount astragal on active leaf.
 - 2. At in-swing pairs of doors, mount astragal on inactive leaf.

3.10 HARDWARE LOCATIONS

- A. Unless otherwise indicated install hardware as follows or as local codes require:
 - 1. Bottom Hinge: 10 inches from door bottom to bottom of hinge.
 - 2. Top Hinge: 5 inches from door top to top of hinge.
 - 3. Center Hinge(s) or Pivot(s): Spaced equidistantly between top and bottom hinges/ pivots.
 - 4. Lockset / Latchset: 38 inches from finished floor to center of lever.
 - 5. Hospital Push-Pull Latchset/ Lockset: 42 inches from finished floor to center of latch.
 - 6. Exit Device: 38 inches from finished floor to device centerline.
 - 7. Deadlock: 32 inches from finished floor to center key cylinder / thumb turn.
 - 8. Push Plate/ Pull Plate: 42 inches from finished floor to center of pull.
 - 9. Wall Bumper: Centered at point on wall where lever, or other operating trim, first makes contact with wall.
 - 10. Floor Stop: Adjacent to wall; not to exceed 4 inches from face of wall; located 3 inches from latch edge of door; in any case never more than 50 percent of door width from latch edge of door.

3.11 ADJUSTING

- A. 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.
- B. Engage a factory-authorized service representative to adjust door closing devices, compensating for final operation of heating and ventilating equipment, and to comply with referenced accessibility requirements.
- C. Follow-up Adjustment: Approximately 6 months after date of Substantial Completion, Installer shall perform the following:
 - 1. Examine and readjust each item of door hardware as necessary to ensure function of 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.

3.12 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant:
 - 1. Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - 2. Independent Architectural Hardware Consultant shall inspect door hardware and prepare written report whether installed work complies with or deviates from requirements, whether door hardware is properly installed and adjusted, and prepare a specific list of any deficiencies, a copy of which shall be provided to Architect.
 - 3. Contractor shall correct all deficiencies noted in above report.
 - 4. Independent Architectural Hardware Consultant shall re-inspect door hardware and prepare a report certifying correction of deficiencies and compliance with requirements.

3.13 COMPLETION

- A. When complete all hardware shall be properly secured in place and all exposed surfaces shall be clean and free from scratches, paint, and other defects and damages.
- B. Contractor shall demonstrate that all keys properly operate the locks as identified in the approved Keying Schedule.

3.14 DOOR HARDWARE SETS

- A. The following is a general listing of hardware requirements. Provide hardware items required by established standards and practices to meet state and local codes, whether or not specifically indicated in the following sets.
- B. Silencers and gasketing, where listed in Hardware Sets, may be omitted at openings where door frames are provided with integral seals if integral seals satisfy all applicable Codes and Regulations.
- C. Refer to Door Schedule and/ or Drawings for door opening information, hardware set assignment, and related requirements.

Set: 1.0

Description: Single Opening – Patient Room (Switch Door)

1	Ligature Resistant Classroom Lock	MRX-A Coordinate with door manufacturer	TOW
1	Cylinder Core		
1	Wall Stop	1842	ABH

Notes: Hinge, locking device, pull, by door manufacturer. Refer to Section 083400

Set: 2.0

Description: Single Opening - Seclusion

1	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
1	Multi-Point Lock	SSRLU-3	DOR
1	Strike Kit	SSRL-SK3	DOR
1	Cylinder and Core		
1	Wall Stop	1842	ABH

Set: 3.0

1	Office Lock x Security Screws	MRX-A x Office	TOW
1	Cylinder Core		
1	Wall Stop	1842	ABH

Notes: Hinge, locking device, pull, by door manufacturer. Refer to Section 083400

Set: 4.0

Description: Single Opening - Quiet Room

1	Ligature Resistant Classroom Lock	MRX-A Coordinate with door manufacturer	TOW
1	Cylinder Core		
1	Wall Stop	1842	ABH

Notes: Hinge, locking device, pull, by door manufacturer. Refer to Section 083400

Set: 5.0

Description: Single Opening – Access Control, Switch Door

1	Ligature Resistant Storeroom Lock	MRX-A Coordinate with door manufacturer	TOW
1	Electric Strike	1600 x Security Head Screws	HES
1	Cylinder Core		
1	Wall Stop	1842	ABH

Notes: Hinge, locking device, pull, by door manufacturer. Refer to Section 083400

Operation:

*Door normally closed and secured.

*Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.

*Upon loss of power door to remain locked from key side.

*Always free egress.

*Access Control reader by security

*Coordinate Power with Electrical/LV Contractor

* Provide Door/Frame Harnesses

Set: 6.0

Description: Single Opening - Office (non-ligature resistant)

	Hinge, Full Mortise, Regular Wt	TA2714	MCK
1	Office/Entry Lock, ADA TT	LB 8205 LNW	SAR
1	Cylinder and Core		
1	Wall Stop	404	ROC
	Silencer	608	ROC

Set: 7.0

Description: Paired Opening – Patient Room

2	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
1	Auto Flush Bolt Set	2848	ROC
1	Dust Proof Strike	570	ROC
1	Ligature Resistant Classroom Lock	MRX-A Coordinate with door manufacturer	TOW
1	Cylinder and Core		
2	Track Arm Closer	4211T/4511T x Security Screws	LCN
1	Coordinator	1700	ROC

Notes:

Provide gasketing at rated doors

Set: 8.0

Description: Single Opening – Seclusion Toilet

1	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
1	Passage Set	MRX-A	TOW
1	Wall Stop	1842	ABH

Set: 9.0

Description: Single Opening - Corridor Toilet

1	Privacy Lock	MRXA-02	TOW
1	Wall Stop	1842	ABH

Notes: Hinge, locking device, pull, by door manufacturer. Refer to Section 083400

Eliminate wall stop where conditions do not permit one

Set: 10.0

Description: Single Opening - Staff Toilet

	Hinge, Full Mortise, Regular Wt	TA2714	MCK
1	Privacy Lock, Occ. Indicator, ADA TT	LB 49 8265 LNW	SAR
1	Surface Closer (mounted on secure side)	281 O/P10	SAR
1	Wall Stop	404	ROC
1	Gasketing (Head & Jambs)	5050C	NGP

Set: 11.0

Description: Single Opening - Staff Toilet

	Hinge, Full Mortise, Regular Wt	TA2714	MCK
1	Privacy Lock, Occ. Indicator, ADA TT	LB 49 8265 LNW	SAR
1	Overhead Stop	9000 Series	ABH
1	Gasketing (Head & Jambs)	5050C	NGP

Set: 12.0

Description: Single Opening - Access Control

1	Continuous Hinge x Hospital Tip x Security Screws, Power Transfer	AC500 HT SEC TW	ABH
1	Ligature Resistant Storeroom lock	MRX-A	TOW
1	Electric Strike	1600 x Security Screws	HES
1	Cylinder and Core		
1	Track Arm Closer	4211T/4511T x Security Screws	LCN
1	Kick Plate x Security Screws	K1050 12" High CSK 4BE x Security	ROC
1	Wall Stop	1842	ABH
1	Push Button	10PBS1 x Security Screws	BEA

Notes:

Provide overhead stop at door 5.C892 in lieu of wall stop.

Provide gasketing at rated doors

Wall stop to be eliminated where conditions do not permit a wall stop.

Operation:

*Door normally closed and secured.

*Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.

*Upon loss of power door to remain locked from key side.

*Always free egress.

*Access Control reader by security

*Coordinate Power with Electrical/LV Contractor

* Provide Door/Frame Harnesses

Electric strike to remain latched when access control system is shunted during day. Push button will unlock electric strike to allow access during unlocked hours.

Set: 13.0

Description: Single Opening – Staff Locker Room

	Hinge, Full Mortise, Regular Wt	TA2714	MCK
1	Push Plate	70C	ROC
1	Door Pull	107 x 70C	ROC

1	Surface Closer (mounted on secure side)	281 O/P10	SAR
1	Kick Plate	K1050 12" High CSK 4BE	ROC
1	Overhead Stop	9000 Series	ABH
1	Gasketing (Head & Jambs)	5050C	NGP

Set: 14.0

Description: Single Opening - Passage

	Hinge, Full Mortise, Regular Wt	TA2714	MCK
1	Passage Latch	8215 LNW	SAR
1	Surface Closer (mounted on secure side)	281 O/P10	SAR
1	Wall Stop	404	ROC
1	Gasketing (Head & Jambs)	5050C	NGP

Notes: Gasketing at rated doors only

Set: 15.0

Description: Single Opening - Access Control - Exterior

1	Continuous Hinge x Hospital Tip x Security Screws, Power Transfer	AC500 HT SEC TW	ABH
1	Asylum Lock	MRX-A	TOW
1	Electric Strike	1600 x Security Screws	HES
2	Cylinder and Core		
1	Track Arm Closer	4211T/4511T x Security Screws	LCN
1	Wall Stop	1842	ABH
1	Threshold	425HD x Security Screws	NGP

Notes:

Provide ligature resistant gasketing

Operation:

*Door normally closed and secured.

*Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.

*Upon loss of power door to remain locked from both sides

- *Access Control readers by security
- *Coordinate Power with Electrical/LV Contractor
- * Provide Door/Frame Harnesses

Set: 16.0

Description: Single Opening - Access Control

1	Continuous Hinge x Hospital Tip x Security Screws, Power Transfer	AC500 HT SEC	ABH
1	Storeroom lock	8204 LNW	SAR
1	Electric Strike	1600 x Security Screws	HES
1	Cylinder and Core		
1	Track Arm Closer	4211T/4511T x Security Screws	LCN
1	Kick Plate x Security Screws	K1050 12" High CSK 4BE x Security	ROC

Notes:

Provide gasketing at rated doors

Operation:

- *Door normally closed and secured.
- *Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.
- *Upon loss of power door to remain locked from key side.
- *Always free egress.
- *Access Control reader by security
- *Coordinate Power with Electrical/LV Contractor
- * Provide Door/Frame Harnesses

Set: 17.0

Description: Single Opening - Access Control

	Hinge, Full Mortise, Hvy Wt	T4A3786	MCK
	Hinge, Full Mortise, Hvy Wt, Power Transfer	T4A3786 QC8	MCK
1	Fail Secure Lock	RX 8271 LNW	SAR
1	Cylinder and Core		

1	Surface Closer (mounted on secure side)	281 O/P10	SAR
1	Kick Plate	K1050 12" High CSK 4BE	ROC
1	Wall stop	404	ROC
1	Gasketing (Head & Jambs)	5050C	NGP

Notes:

Provide fail safe at door 5.C879.

Provide 1 Armor Plate 30" High and delayed action closer @ door 5.889.1

Operation:

*Door normally closed and secured.

*Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.

*Built in request to exit switch to shunt door position switch

*Door position switch to be tied into security system to monitor status of door.

*Upon loss of power door to remain locked from key side.

*Always free egress.

*Access Control reader by security

*Coordinate Power with Electrical/LV Contractor

* Provide Door/Frame Harnesses

Set: 18.0

Description: Paired Opening - Access Control

1	Continuous Hinge x Hospital Tip x Security Screws, Power Transfer	AC500 HT SEC TW	ABH
1	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
1	Auto Flush Bolt Set	2848	ROC
1	Dust Proof Strike	570	ROC
1	Ligature Resistant – Fail Secure	XMRX-A	TOW
1	Cylinder and Core		
2	Door Closers	281 P10 (Mounted on push side)	SAR
1	Coordinator	1700	ROC

Notes:

Provide gasketing at rated doors

Operation:

*Door normally closed and secured.

*Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.

*Upon loss of power door to remain locked from key side.

*Always free egress.

*Access Control reader by security

*Coordinate Power with Electrical/LV Contractor

* Provide Door/Frame Harnesses

Set: 19.0

Description: Paired Opening - Double Egress, Card Access

2	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
1	Magnetic Lock	M680EBD	SEC
2	Concealed Vert Rod Exit, Exit Only	[12] 43 36 NB 8610 EO	SAR
2	Track Arm Closer	4211T/4511T x Security Screws	LCN
1	Astragal	303APK x Security Security Screws	PEM
1	Perimeter Gasketing	316AV (Head and Jambs) x Security Screws	PEM
1	Harness - Frame		MCK
1	Motion Sensor	XMS	SEC
1	Push Button	EEB2	SEC

Notes:

With loss of power or fire alarm, doors to remain locked. Free egress from side with motion sensor and exit button.

Set: 20.0

Description: Single Opening - Access Control – Both Sides

1	Continuous Hinge x Hospital Tip x Security Screws, Power Transfer	AC500 HT SEC	ABH
1	Asylum Lock	MRX-A	TOW
1	Electric Strike	1600 x Security Screws	HES
2	Cylinder and Core		
1	Track Arm Closer	4211T/4511T x Security Screws	LCN

1	Kick Plate x Security Screws	K1050 12" High CSK 4BE x Security	ROC
1	Wall Stop	1842	ABH

Notes: Closer non public side of opening

Provide gasketing at rated doors

Operation:

*Door normally closed and secured from both sides.

*Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.

*Door position switch to be tied into security system to monitor status of door.

*Upon loss of power door to remain locked

*Access Control reader by security

*Coordinate Power with Electrical/LV Contractor

* Provide Door/Frame Harnesses

Set: 21.0

Description: Paired Opening - Double Egress, Card Access

2	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
2	Magnetic Lock	M680EBD	SEC
2	Concealed Vert Rod Exit, Exit Only	[12] 43 36 NB 8610 EO	SAR
2	Track Arm Closer	4211T/4511T x Security Screws	LCN
1	Astragal	303APK x Security Security Screws	PEM
1	Perimeter Gasketing	316AV (Head and Jambs) x Security Screws	PEM
1	Harness - Frame		MCK

Notes:

With loss of power or fire alarm, doors to remain locked

Card reader at both sides

Set: 22.0

Description: Paired Opening - Double Egress

2	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
2	Concealed Vert Rod Exit, Exit Only	[12] 43 36 NB 8610 EO	SAR

2	Track Arm Closer	4211T/4511T x Security Screws	LCN
1	Astragal	303APK x Security Security Screws	PEM
1	Perimeter Gasketing	316AV (Head and Jambs) x Security Screws	PEM
2	Magnetic Hold Open	2600	ABH

Set: 23.0

Description: Paired Opening – Access Control – One Side

2	Continuous Hinge x Hospital Tip x Security Screws	AC500 HT SEC	ABH
2	Door Pulls	107 x Security Screws	ROC
2	Push Plates	70C x Security Screws	ROC
2	Track Arm Closer	4211T/4511T x Security Screws	LCN
2	Magnetic Hold Open	2600	ABH

Set: 24.0

Description: Single Opening - Storage

	Hinge, Full Mortise, Regular Wt	TA2714	MCK
1	Storeroom Lock Cylinder and Core	8204 LNW	SAR
1	Surface Closer (mounted on secure side)	281 O/P10	SAR
1	Wall Stop	404	ROC
1	Gasketing (Head & Jambs)	5050C	NGP

Notes: Gasketing at rated doors only

Set: 25.0

Description: Single Opening - Access Control – Fail Safe

	Hinge, Full Mortise, Hvy Wt	T4A3786	MCK
	Hinge, Full Mortise, Hvy Wt, Power Transfer	T4A3786 QC8	MCK
1	Fail Secure Lock	RX 8270 LNW	SAR
1	Cylinder and Core		

1	Surface Closer (mounted on secure side)	281 O/P10	SAR
1	Kick Plate	K1050 12" High CSK 4BE	ROC
1	Wall stop	404	ROC
1	Gasketing (Head & Jambs)	5050C	NGP

Notes:

Operation:

*Door normally closed and secured.

*Upon use of mechanical key or presentation of authorized credentials door to unlock allowing authorized entry.

*Built in request to exit switch to shunt door position switch

*Door position switch to be tied into security system to monitor status of door.

*Upon loss of power door to remain unlocked from key side.

*Always free egress.

*Access Control reader by security

*Coordinate Power with Electrical/LV Contractor

* Provide Door/Frame Harnesses

END OF SECTION 087100

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Glass and glazing for sections referencing this Section for Products and installation hollow metal work, windows and glazed doors.

1.2 **ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-Installation Meetings: Convene meeting one (1) week before beginning Work of this section, with Contractor, Subcontractor and Consultant in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify Project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other Subcontractors.
 - .4 Review manufacturer's written installation instructions and warranty requirements.
- .2 Sequencing: Comply with manufacturer's recommendations for sequencing construction operations.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, product literature and data sheets for glass, sealants and glazing accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit Workplace Hazardous Materials Information System (WHMIS) safety data sheets (SDS).
- .3 Shop Drawings: Submit Shop Drawings stamped and signed by professional engineer registered or licensed in province, Canada.
- .4 Samples:
 - .1 Submit for review and acceptance of each type of unit.
 - .2 Samples will not be returned for inclusion into Work.
 - .3 Submit duplicate 300 x 300 mm size samples of glass and sealant material.
 - .4 Submit duplicate manufacturer samples of surface-applied glazing films.
- .5 Certificates: Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .6 Test Reports:
 - .1 Certified test reports showing compliance with specified performance characteristics and physical properties.
 - .2 Submit testing and analysis of glass under provisions of Section 01 40 00 - Quality Requirements.
 - .3 Submit shop inspection and testing for glass.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

- .1 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .2 Products of this Section: Manufactured to ISO 9000 ISO 14000 certification requirements.
- .3 Perform Work in accordance with Insulating Glass Manufacturers Alliance (IGMA) Glass Association of North America (GANA) Glazing Manual GANA Sealant Manual GANA Laminated Glazing Manual for glazing installation methods. Maintain one (1) copy of document on Site.
- .4 Installer Qualifications: Company specializing in performing the Work of this section with minimum three (3) years documented experience and approved by the manufacturer.
- .5 Mock-Ups:
 - .1 Construct mock-ups in accordance with Section 01 40 00 - Quality Requirements.
 - .2 Construct mock-up to include glass glazing.
 - .3 Mock-up will be used:
 - .1 To judge quality of work, substrate preparation and material application.
 - .2 For testing to determine compliance with performance requirements. Perform tests as follows:
 - .4 **Consultant** will require minimum twenty-four (24) hours to review the mock-up.
 - .5 Approved mock-up may remain as part of finished Work.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in a clean dry location and in accordance with manufacturer's recommendations.
 - .2 Store and protect glazing from nicks, scratches and edge damage.
 - .3 Protect prefinished aluminum surfaces with wrapping and strippable coating.
 - .4 Replace defective or damaged materials with new.

1.7 AMBIENT CONDITIONS

- .1 Ambient Requirements:
 - .1 Install glazing when ambient temperature is 10°C minimum. Maintain ventilated environment for twenty-four (24) hours after application.

- .2 Maintain minimum ambient temperature before, during and [twenty-four (24)] hours after installation of glazing compounds.
- .3 Refer to manufacturer's instructions for minimum ambient temperature for application of bird deterrent glazing film.

Part 2 Products

2.1 **MANUFACTURERS**

.1 **Subject to compliance with requirements, provide products by one of the following or approved substitute:**

- .1 AFG Industries, Inc. www.afgglass.com.
- .2 Guardian Industries Corp. www.guardian.com.
- .3 Oldcastle Glass: www.oldcastleglass.com.
- .4 PPG Industries, Inc. www.ppg.com.
- .5 Viracon: www.viracon.com.

2.2 **MATERIALS – GENERAL**

- .1 Design Criteria: Limit glass deflection to flexural limit of glass with full recovery of glazing materials.

2.3 **GLASS PRODUCTS, GENERAL**

.1 Thickness:

- .1 Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
- .2 Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.

- .2 Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

- .3 Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

- .1 For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
- .2 Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.4 **GLASS PRODUCTS**

- .1 Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- .2 Heat-Strengthened Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated, Kind HS.

.3 Tempered Float Glass:

- .1 ASTM C1048, Type I, Quality Q3, Class 1 (clear), Kind FT. 1. Glass shall be horizontally heat treated with minimal waviness or distortion at bottom edge of glass and free of tong marks.
- .2 Maximum peak to valley rollerwave 0.003" in the central area and 0.008" within 10 ½" of the leading and trailing edge.
- .3 Maximum bow and warp 1/32"/foot.
- .4 All tempered architectural safety glass shall conform with ANSI Z97.1 and CPSC 16 CFR 1201

2.5 **LAMINATED-GLASS**

- .1 Laminated Glass: ASTM C1172 and complying with other requirements specified.
- .2 Interlayer: Polyvinyl butyral of thickness indicated with no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass panes and installation.
- .3 Glass Types:
 - .1 Glass Type IG-1 - Laminated Tempered Glass Units:
 - .1 Kind LA, consisting of two (2) panes of heat-strengthened, fully tempered float glass.
 - .2 Outer Pane: Class 1 (clear) fully tempered float glass. Thickness: 6 mm.
 - .3 Interlayer:
 - i. Thickness: 0.06 PVB, or as required to comply as a Type II Safety Glass material.
 - ii. Color: Clear.
 - .4 Inner Pane: Class I (clear) fully tempered float glass. Thickness 6 mm.
 - .2 Glass Type IG-2 - Laminated Tempered Glass Units - Fritted:
 - .1 Kind LA, consisting of two (2) panes of heat-strengthened, fully tempered float glass.
 - .2 Outer Pane: Class 1 (clear) fully tempered float glass. Thickness: 6 mm.
 - .3 Interlayer:
 - i. Thickness: 0.06 PVB, or as required to comply as a Type II Safety Glass material.
 - ii. Color: Clear.
 - .4 Inner Pane: Class I (clear) fully tempered float glass. Thickness 6 mm.
 - .3 Glass Type IG-3 - Fire-Rated Protective Glazing (FRPG):
 - .1 Basis of Design: Subject to compliance with requirements, provide "FireLite Glass" as manufactured by Nippon Electric Glass Company, Ltd.: <http://www.fireglass.com>, or approved alternate by one (1) of the following:
 - i. General Glass International.
 - ii. SaftiFirst.
 - .2 Fire Ratings: As scheduled on the Drawings.

- .3 Glass Thickness: As required for fire rating.

2.6 GLAZING COMPOUND FOR FIRE-RATED GLAZING MATERIALS

- .1 Glazing Materials - Provide one (1) of the following:
 - .1 Glazing Tape: Closed cell polyvinyl chloride (PVC) foam, coiled on release paper over adhesive on two (2) sides, maximum water absorption by volume of 2%. Glass panels that exceed 1,393 inch² for ninety (90) minute ratings must be glazed with fire-rated glazing tape supplied by manufacturer.
 - .2 Glazing Compound: DAP 33 putty.
 - .3 Silicone Sealant: One (1) part neutral curing silicone, medium modulus sealant, Type S, Grade NS; Class 25 with additional movement capability of 50% in both extension and compression (total 100%); Use (Exposure) NT; Uses (Substrates) G, A, and O as applicable. Available Products:
 - .1 Dow Corning 795 - Dow Corning Corp.
 - .2 Silglaze-II 2800 - General Electric Co.
 - .3 Spectrem 2 - Tremco Inc.
- .2 Setting Blocks: Neoprene, EPDM, or silicone, tested for compatibility with glazing compound; of 70 to 90 Shore A hardness.
- .3 Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.

2.7 ACCESSORIES

- .1 Setting Blocks: Silicone 80-90 Shore A durometer hardness to ASTM D2240, to suit glazing method, glass lite weight and area.
- .2 Spacer Shims: Silicone, 50-60 Shore A durometer hardness to ASTM D2240, 75 mm long x one half (½) height of glazing stop x thickness to suit application. Self-adhesive on one (1) face.
- .3 Glazing Tape:
 - .1 Preformed butyl compound with integral resilient tube spacing device, 10-15 Shore A durometer hardness to ASTM D2240; coiled on release paper, size as required, black colour.
 - .2 Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two (2) sides, maximum water absorption by volume 2%, designed for compression of 25%, to affect an air and vapour seal, size as required.
- .4 Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot, colour as selected.
- .5 Glazing Clips: Manufacturer's standard type.
- .6 Lock-Strip Gaskets: To ASTM C542.

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting *Work*.

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

3.2 PREPARATION

- .1 Clean contact surfaces with solvent and wipe dry.
- .2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .3 Prime surfaces scheduled to receive sealant.
- .4 Preparation - Glazing films:
 - .1 Clean glazing before beginning installation using neutral cleaning solution.
 - .2 Ensure no deleterious material adheres to glazing.
 - .3 Ensure dust, grease and chemical residue are removed from surface of glazing before installation of film.
 - .4 Examine glazing under natural daylight and identify cracks, blisters, bubbles, discolouration, edge defects or other anomalies that may cause film to delaminate or cause vision transparency or distortion problems.

3.3 INSTALLATION - EXTERIOR DRY METHOD (PREFORMED GLAZING)

- .1 Manufacturer's Instructions: Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions and data sheets.
- .2 Perform work in accordance with GANA Glazing Manual and GANA Laminated Glazing Reference Manual for glazing installation methods.
- .3 Cut glazing **tape** to length; install on glazing lite. Seal corners by butting **tape** and sealing junctions with sealant.
- .4 Place setting blocks at one quarter ($\frac{1}{4}$) points, with edge block maximum **150** mm from corners.
- .5 Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
- .6 Install removable stops without displacing glazing tape. Exert pressure for full continuous contact.
- .7 Trim protruding tape edge.

3.4 CLEANING

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Remove traces of primer and sealants.
 - .3 Remove glazing materials from finish surfaces.
 - .4 Remove labels.
 - .5 Clean glass and mirrors using approved non-abrasive cleaner in accordance with manufacturer's instructions.
- .2 Waste Management: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.

3.5 PROTECTION

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

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Fluid applied, resin based, membrane forming systems that control the moisture vapor emission rate of high moisture, interior concrete to prepare it for floor covering installation.

1.2 **UNIT PRICES**

- .1 Work of this Section is affected by the moisture vapor emission control unit price. When testing conducted in other Sections demonstrates moisture vapor emission values are within finish flooring manufacturers limits, the Owner will execute a deductive change order deleting vapor control system for that portion of the Work on a unit cost square footage basis.

1.3 **DEFINITIONS**

- .1 MVE: Moisture vapor emission.
- .2 MVER: Moisture vapor emission rate.

1.4 **ACTION SUBMITTALS**

- .1 Product Data: For each type of Product.

1.5 **INFORMATIONAL SUBMITTALS**

- .1 Qualification Data: For installer and manufacturer.
- .2 Product Test Reports: For MVE control system, for tests performed by a qualified testing agency.
- .3 Field quality control reports.

1.6 **QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Employs factory trained personnel who are available for consultation and Project site inspection.
- .2 Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.8 **FIELD CONDITIONS**

- .1 Environmental Limitations:
 - .1 Comply with MVE control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation and other conditions affecting installation.
 - .2 Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65°F (18°C) and not more than 85°F (29.4°C) at least forty-eight (48) hours before use.
 - .3 Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE control system manufacturer, but not less than 65°F (18°C) or more than 85°F (29.4°C) and not less than 40% or more than 60% relative humidity, for forty-eight (48) hours before installation, during installation and for forty-eight (48) hours after installation unless longer period is recommended in writing by manufacturer.

- .4 Install MVE control systems where concrete surface temperatures will remain a minimum of 5°F (3°C) higher than the dew point for ambient temperature and relative humidity conditions in installation areas for forty-eight (48) hours before installation, during installation and for forty-eight (48) hours after installation unless longer period is recommended in writing by manufacturer.

1.9 **WARRANTY**

.1 Manufacturer's Special Warranty:

- .1 Provide manufacturer's written warranty guaranteeing the integrity of the MVE control system to be free of manufacturing defects, remain adhered to substrate and not be affected by moisture or alkalinity and covering coating failure caused by concrete moisture vapor emission and alkalinity.
- .2 Warranty covers cost of MVE control system, preparation and installation of compounds and labor charges associated to repair or replace materials in areas exhibiting failure caused by concrete moisture vapor emission and alkalinity damage, including replacing floor covering materials and removing, storing and reinstalling equipment and furnishings.

.2 Period of Warranty: Not less than twenty (20) years.

Part 2 **Products**

2.1 **PERFORMANCE REQUIREMENTS**

- .1 MVE Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
 - .1 MVER: Maximum 25 lb of water/1000 ft² when tested according to ASTM F1869.
 - .2 Relative Humidity: Maximum 90% when tested to ASTM F2170 using in situ probes.
- .2 Water Vapor Transmission: Through MVE control system, maximum 0.1 perm when tested according to ASTM E96/E96M.
- .3 Tensile Bond Strength: For MVE control system, greater than 200 psi with failure in the concrete according to ASTM D7234.

2.2 **MVE CONTROL SYSTEM**

- .1 MVE Control System Epoxy: ASTM F3010 qualified, fluid applied, two (2) component, epoxy resin, membrane forming system, formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering Products indicated, including adhesives.
- .2 Products: Subject to compliance with requirements, provide one (1) of the following:
 - .1 ARDEX Americas: MC Ultra Moisture Control System. <https://www.ardexamericas.com>.
 - .2 KOSTER American Corporation: Koster VAP I 2000 Zero VOC. www.kosterusa.com.
 - .3 MAPEI Corporation: Planiseal VS Fast <https://www.mapei.com/ca/en-ca>.
- .3 Substrate Primer: Provide MVE control system manufacturer's concrete substrate primer if required for system indicated by substrate conditions.
- .4 Cementitious Underlayment Primer: If required for subsequent installation of cementitious underlayment Products, provide MVE control system manufacturer's primer to ensure adhesion of Products to MVE control system.

.5 MVE Control System Polymer:

- .1 Two (2) component, synthetic polymer, formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering Products indicated, including adhesives.
- .2 Products: Subject to compliance with requirements, provide one (1) of the following:
 - .1 Advanced Moisture Control, Inc.; Vapor Green FC.
 - .2 Dependable, LLC; Cutdown II.
- .3 Substrate Primer: Provide MVE control system manufacturer's concrete substrate primer if required for system indicated by substrate conditions.
- .4 Cementitious Underlayment Primer: If required for subsequent installation of cementitious underlayment Products, provide MVE control system manufacturer's primer to ensure adhesion of Products to MVE control system.

2.3 **ACCESSORIES**

- .1 Patching and Leveling Material: Moisture, mildew and alkali resistant Product recommended in writing by MVE control system manufacturer and with minimum of 3000 psi (20.68 MPa) compressive strength after twenty-eight (28) days when tested according to ASTM C109/C109M.
- .2 Crack Filling Material: Resin based material recommended in writing by MVE control system manufacturer for sealing concrete substrate crack repair.
- .3 Cementitious Underlayment: If required to maintain manufacturer's warranty, provide MVE control system manufacturer's hydraulic cement-based underlayment.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting *Work*.
- .2 Examine substrates and conditions, with installer present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the *Work*.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.
- .4 Installation of system indicates acceptance of surfaces and conditions.

3.2 **PREPARATION**

- .1 Preinstallation Testing:
 - .1 Testing Agency: Engage a qualified testing agency to perform tests.
 - .2 Refer to individual flooring sections in Division 09 for testing requirements.
 - .3 Tensile Bond Strength Testing:
 - .1 For typical locations indicated to receive installation of MVE control system, install minimum 100 ft² area of MVE control system to prepared concrete substrate and test according to ASTM D7234.
 - .2 Proceed with installation only where tensile bond strength is greater than 200 psi with failure in the concrete.
- .2 Concrete Substrates:
 - .1 Prepare and clean substrates according to MVE control system manufacturer's written instructions to ensure adhesion of system to concrete.

- .2 Remove coatings and other substances that are incompatible with MVE control system and that contain soap, wax, oil or silicone, using mechanical methods recommended in writing by MVE control system manufacturer. Do not use solvents.
- .3 Provide concrete surface profile complying with ICRI 310.2R by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus and recirculates the shot by vacuum pickup.
- .4 After shot blasting, repair damaged and deteriorated concrete according to MVE control system manufacturer's written instructions.
- .5 Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
- .6 Fill surface depressions and irregularities with patching and leveling material.
- .7 Fill surface cracks, grooves, control joints and other non-moving joints with crack filling material.
- .8 Allow concrete to dry, undisturbed, for period recommended in writing by MVE control system manufacturer after surface preparation, but not less than twenty-four (24) hours.
- .9 Before installing MVE control systems, broom sweep and vacuum prepared concrete.
- .3 Protect walls, floor openings, electrical openings, door frames and other obstructions during installation.

3.3 **INSTALLATION**

- .1 Install MVE control system according to ASTM F3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fisheyes and voids. Install primers as required to comply with manufacturer's written instructions.
- .2 Do not apply MVE control system across substrate expansion, isolation and other moving joints.
- .3 Cure MVE control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.
- .4 After curing, examine MVE control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.
- .5 Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

3.4 **FIELD QUALITY CONTROL**

- .1 Testing Agency: Engage a qualified testing agency to perform installation inspections.
- .2 Installation Inspections:
 - .1 Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE control system is installed without deficiencies.
 - .2 Verify that surface preparation meets requirements.
 - .3 Verify that component coats and complete MVE control system film thicknesses comply with manufacturer's written instructions.
 - .4 Verify that MVE control system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.
- .3 Alkalinity Testing: Perform pH testing according to ASTM F710. Install MVE control system in areas where pH readings are less than 7 and in areas where pH readings are greater than 8.5.
- .4 Moisture Testing: Perform tests so that each test area does not exceed 200 ft² and perform no fewer than three (3) tests in each installation area and with test areas evenly spaced in installation areas.

- .5 Anhydrous Calcium Chloride Test: ASTM F1869. Install MVE control system in locations where concrete substrate MVER exceeds 3 lbs of water/1000 ft² in twenty-four (24) hours.
- .6 MVE control system will be considered defective if it does not pass inspections.

3.5 **PROTECTION**

- .1 Protect MVE control system from damage, wear, dirt, dust and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE control system manufacturer.
- .2 Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture or otherwise compromise the MVE control system membrane.

END OF SECTION 09 05 61

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Gypsum wallboard (GWB) and joint treatment.

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's instructions, printed product literature and data sheets for GWB assemblies and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit GWB assembly drawings stamped and signed by professional engineer registered or licensed in province or territory where Project is located.
 - .2 Indicate components such as fastener type, dimensions, spacing and locations at GWB edges, ends and in field of board as well as installation methods. Components and work to confirm to ASTM C 840 standard specification for application and finishing of GWB.
 - .3 Indicate type of joint compound and number of joint compound layers.
 - .4 Indicate number and location of electrical boxes for wall and ceiling.
- .4 Samples:
 - .1 Submit for review and acceptance of each component specified or necessary for complete installation. Include technical descriptive data.
 - .2 Submit duplicate 300 x 300 mm size samples of vinyl faced GWB and 300 mm long samples of corner and casing beads, vinyl moldings, shadow mold, textured finishes and/or insulating strip.
 - .3 Samples will be returned for inclusion into work.
- .5 Certifications: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 **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 Project site in original factory packaging, labelled with manufacturer's name and address and applicable standard designation.
- .3 Exercise care in unloading GWB materials shipment to prevent damage.
- .4 Storage and Handling Requirements:
 - .1 In accordance with ASTM C 840-16.
 - .2 Store GWB materials level flat off ground indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .3 Store and protect GWB from nicks, scratches and blemishes.
 - .4 Protect GWB from direct exposure to rain, snow, sunlight or other excessive weather conditions.

- .5 Protect ready mix joint compounds from freezing, exposure to extreme heat and direct sunlight.
- .6 Protect from weather, elements and damage from construction operations.
- .7 Handle GWBs to prevent damage to edges, ends or surfaces.
- .8 Protect prefinished aluminum surfaces with wrapping and strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.
- .9 Replace defective or damaged materials with new.
- .5 Packaging Waste Management: Remove pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 00 - Cleaning and Waste Management.

1.4 **AMBIENT CONDITIONS**

- .1 Maintain temperature 10°C minimum, 21°C maximum for forty-eight (48) hours prior to and during application of GWBs and joint treatment and for forty-eight (48) hours minimum after completion of joint treatment.
- .2 Apply board and joint treatment to dry, clean, frost-free surfaces.
- .3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part 2 **Products**

2.1 **MATERIALS**

- .1 Standard board to ASTM C1396/C1396M-14 regular, thickness as indicated on the Drawings and Type X, thickness as indicated on the Drawings, 1200 mm wide x maximum practical length, ends square cut, edges as indicated on the Drawings.
- .2 Gypsum sheathing board to ASTM C1396/C1396M-14, regular, thickness as indicated on the Drawings and Type X, thickness as indicated on the Drawings, 1200 mm wide x maximum practical length.
- .3 Vinyl-faced board to ASTM C1396/C1396M-14, Class I regular, thickness as indicated on the Drawings and Type X, thickness as indicated on the Drawings, covered with minimum 0.15 mm thick wall covering having maximum flame spread: 25, fuel contributed: 35, smoke developed: 50 when tested to CAN/ULC-S102-10 and colour thickness as indicated on the Drawings.
- .4 Backing board and core board to ASTM C1396/C1396M-14 regular, thickness as indicated on the Drawings and Type X, thickness as indicated on the Drawings, edges as indicated on the Drawings.
- .5 Water-resistant board to ASTM C1396/C1396M-14 regular, thickness as indicated on the Drawings and Type X, thickness as indicated on the Drawings, in maximum practical length.
- .6 Glass mat water-resistant gypsum backing board to ASTM C1178/C1178M-13, thickness as indicated on the Drawings, 1200 mm wide x maximum practical length.
- .7 Glass mat gypsum substrate sheathing to ASTM C1177/C1177M-13, thickness as indicated on the Drawings, 1200 mm wide x maximum practical length.
- .8 Drywall furring channels 0.5 mm core thickness galvanized steel channels for screw attachment of GWB.

- .9 Resilient clips or drywall furring 0.5 mm base steel thickness galvanized steel for resilient attachment of GWB.
- .10 Nails: to ASTM C514-14.
- .11 Steel drill screws to ASTM C1002-14
- .12 Stud adhesive to CAN/CGSB-71.25.
- .13 Laminating compound as recommended by manufacturer, asbestos-free.
- .14 Casing beads, corner beads, control joints and edge trim to ASTM C1047, Zinc-coated by hot-dip process 0.5 mm base thickness, perforated flanges, one piece length per location.
- .15 Cornice Cap: As indicated on the Drawings. Include splice plates for joints.
- .16 Shadow Mold: As indicated on the Drawings.
- .17 Moldings for joint treatment of vinyl faced GWB, as supplied by GWB manufacturer and as indicated on the Drawings.
- .18 Sealants:
 - .1 In accordance with Section 07 92 00 - Joint Sealants.
 - .2 VOC limit 250 g/L maximum to SCAQMD Rule 1168.
 - .3 Acoustic sealant: in accordance with Section 07 92 00 - Joint Sealants.
- .19 Polyethylene to CAN/CGSB-51.34, Type 2
- .20 Insulating Strip: Rubberized, moisture resistant, 3 mm thick cork closed cell neoprene strip, 12 mm wide, with self-sticking permanent adhesive on one (1) face, lengths as required.
- .21 Joint compound to ASTM C475, asbestos-free.

2.2 FINISHES

- .1 Texture Finish: Asbestos-free standard white texture coating and primer-sealer, recommended by GWB manufacturer.
- .2 Primer: VOC limit 50 g/L maximum to SCAQMD Rule 1113.

Part 3 Execution

3.1 EXAMINATION

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

3.2 ERECTION

- .1 Do application and finishing of GWB to ASTM C840-16 except where specified otherwise.
- .2 Do application of gypsum sheathing to ASTM C1280-13a.

- .3 Erect hangers and runner channels for suspended GWB ceilings to ASTM C840-16 except where specified otherwise.
- .4 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .5 Install work level to tolerance of 1:1200.
- .6 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers and grilles.
- .7 Install 19 x 64 mm furring channels parallel to and at exact locations of steel stud partition header track.
- .8 Furr for GWB faced vertical bulkheads within and at termination of ceilings.
- .9 Furr above suspended ceilings for GWB fire and sound stops and to form plenum areas as indicated.
- .10 Install wall furring for GWB wall finishes to ASTM C840-16, except where specified otherwise.
- .11 Furr openings and around built-in equipment, cabinets, access panels on four (4) sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .12 Furr duct shafts, beams, columns, pipes and exposed services where indicated.
- .13 Erect drywall resilient furring transversely across studs, joists and/or between layers of GWB, spaced maximum 600 mm o.c. and not more than 150 mm from ceiling/wall juncture. Secure to each support with 38 mm common nail 25 mm drywall screw.
- .14 Install 150 mm continuous strip of 12.7 mm GWB along base of partitions where resilient furring installed.

3.3 APPLICATION

- .1 Apply GWB after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.
- .2 Apply single and/or double layer GWB to metal furring or framing using screw fasteners for first layer, screw fasteners for second layer. Maximum spacing of screws 300 mm o.c.:
 - .1 Single-Layer Application:
 - .1 Apply GWB on ceilings prior to application of walls to ASTM C840-16.
 - .2 Apply GWB on walls vertically or horizontally, providing sheet lengths that will minimize number of board edges or end joints.
 - .2 Double-Layer Application:
 - .1 Install GWB for base layer and exposed GWB for face layer.
 - .2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.
 - .3 Apply base layers at right angles to supports unless otherwise indicated.
 - .4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.

- .3 Apply single and/or double layer GWB to concrete and/or concrete block surfaces, where indicated, using laminating adhesive:
 - .1 Comply with GWB manufacturer's recommendations.
 - .2 Brace or fasten GWB until fastening adhesive has set.
 - .3 Mechanically fasten GWB at top and bottom of each sheet.
- .4 Apply water-resistant GWB where wall tiles to be applied and adjacent to slop sinks and/or janitors' closets. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads. Do not apply joint treatment on areas **to** receive tile finish.
- .5 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal GWB/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes and ducts, in partitions where perimeter sealed with acoustic sealant.
- .6 Arrange vinyl faced GWB symmetrical about openings and wall areas, with butt joints aluminum/vinyl moldings between joints.
- .7 Apply board using stud adhesive on furring or framing and laminating adhesive on base layer of GWB.
- .8 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.
- .9 Install GWB on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .10 Install GWB with face side out.
- .11 Do not install damaged or damp boards.
- .12 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 **INSTALLATION**

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Miter and fit corners accurately, free from rough edges. Secure at 150 mm o.c. using contact adhesive for full length.
- .2 Install casing beads around perimeter of suspended ceilings.
- .3 Install casing beads where GWB butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of GWB and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Install shadow mold at GWB/ceiling juncture as indicated. Minimize joints, use corner pieces and splicers.
- .6 Construct control joints of preformed units set in GWB facing and supported independently on both sides of joint.
- .7 Provide continuous polyethylene dust barrier behind and across control joints.
- .8 Locate control joints where indicated.
- .9 Install control joints straight and true.

- .10 Ensure that screws or nails are properly applied in process of attaching GWB to framing without damaging of GWB edges and ends.
- .11 Construct expansion joints as detailed, at building expansion and construction joints. Provide continuous dust barrier.
- .12 Install expansion joint straight and true.
- .13 Install cornice cap where GWB partitions do not extend to ceiling.
- .14 Fit cornice cap over partition, secure to partition track with two rows of sheet metal screws staggered at 300 mm o.c.
- .15 Splice corners and intersections together and secure to each member with three (3) screws.
- .16 Install access doors to electrical and mechanical fixtures specified in respective sections. Rigidly secure frames to furring or framing systems.
- .17 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .18 GWB Finish: Finish GWB walls and ceilings to following levels in accordance with AWCI Levels of GWB Finish:
 - .1 Levels of Finish:
 - .1 Level 0: No tapping, finishing or accessories required.
 - .2 Level 1: Embed tape for joints and interior angles in joint compound. Surfaces free of excess joint compound; tool marks and ridges are acceptable.
 - .3 Level 2: Embed tape for joints and interior angles in joint compound and apply one (1) separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable.
 - .4 Level 3: Embed tape for joints and interior angles in joint compound and apply two (2) separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.
 - .5 Level 4: Embed tape for joints and interior angles in joint compound and apply three (3) separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.
 - .6 Level 5: Embed tape for joints and interior angles in joint compound and apply three (3) separate coats of joint compound over joints, angles, fastener heads and accessories; apply a thin skim coat of joint compound to entire surface; surfaces smooth and free of tool marks and ridges.
- .19 Finish corner beads, control joints and trim as required with two (2) coats of joint compound and one (1) coat of taping compound, feathered out onto panel faces.
- .20 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of GWB, invisible after surface finish is completed.
- .21 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

- .22 Completed installation smooth, level or plumb, free from waves and other defects and ready for surface finish.
- .23 Apply one (1) coat of white primer sealer over surface to be textured. When dry apply textured finish in accordance with manufacturer's instructions.
- .24 Mix joint compound slightly thinner than for joint taping.
- .25 Apply thin coat to entire surface using trowel or drywall broad knife to fill surface texture differences, variations or tool marks.
- .26 Allow skim coat to dry completely.
- .27 Remove ridges by light sanding or wiping with damp cloth.

3.5 **CLEANING**

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Leave Work area clean at end of each day.
 - .3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.

3.6 **PROTECTION**

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

3.7 **SCHEDULES**

- .1 Construct fire rated assemblies where indicated on the Drawings.
- .2 Refer to Drawings for partition types.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Formed metal framing of studs and furring, at interior locations.
- .2 Framing accessories.

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal framing and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) safety data sheet (SDS) in accordance with Section 01 35 23 - Health and Safety.
- .3 Samples: Submit duplicate 300 mm long samples of non-structural metal framing.

1.3 **QUALITY ASSURANCE**

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

1.4 **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 indoors, off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal framing from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 **MATERIALS**

- .1 Non-Load Bearing Channel Stud Framing:
 - .1 To ASTM C645, stud size(s) as indicated on the Drawings, roll formed from 0.91 mm thickness hot dipped zinc-coated (galvanized) steel sheet in accordance with ASTM A653, Z180, for screw attachment of gypsum wallboard (GWB).
 - .2 Knock-out service holes at 460 mm o.c.

- .2 Floor and ceiling tracks to ASTM C645, in widths to suit stud sizes, and as follows:
 - .1 Slotted Deflection Track for Fire Separations: Premanufactured slotted top runner with 63 mm down standing legs and having 6 mm wide x 38 mm high slots spaced at 25 mm o.c. along length of runner; tested and certified for use in fire rated wall construction.
 - .2 Double Runner Deflection Track: Outside runner using 50 and/or 75 mm flanges as indicated on the Drawings; inner runner 33 mm; maintaining 25 mm minimum deflection space.
 - .3 Deep Leg Deflection Track: Top runner having 50 and/or 75 mm down standing legs as indicated on the Drawings; maintaining 13 mm minimum deflection space.
 - .4 Base Runner: Bottom track with 33 mm upstanding legs.
- .3 Furring Channels: Commercial steel sheet in accordance with ASTM A653, Z180, hot dipped zinc-coated (galvanized), as follows:
 - .1 Hat Shaped, Rigid Furring Channels: ASTM C645, 0.75 mm thickness x 22 mm deep.
 - .2 Resilient Furring Channels: 0.46 mm thickness x 13 mm deep members designed to reduce sound transmission having asymmetrical face attached to single flange by a slotted leg (web).
- .4 Curving Tracks: Commercial steel sheet with ASTM A653, Z180, hot dipped zinc-coated (galvanized), complete with flexible sliding straps to allow for curvature indicated on drawings; width to suit framing, and as follows:
 - .1 Width as indicated on the Drawings.
 - .2 Minimum base metal thickness: 0.75 mm.
- .5 Metal channel stiffener: Size as indicated on the Drawings, 1.4 mm thick cold rolled steel, coated with rust inhibitive coating.
- .6 Sealant in accordance with Section 07 92 00 - Joint Sealants.
- .7 Sealants: VOC limit in accordance with Section 07 92 00 - Joint Sealants.
- .8 Insulating Strip: Rubberized, moisture resistant 3 mm thick cork or foam strip, 12 mm wide, with self-sticking adhesive on one face, lengths as required.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for non-structural metal framing application in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 ERECTION

- .1 Erect partitions in accordance with framing requirements of ASTM C754
- .2 Align partition tracks at floor and ceiling and secure at 610 mm o.c. maximum.
- .3 Install damp proof course under stud shoe tracks of partitions on slabs on grade.
- .4 Place studs vertically not more than 50 mm from abutting walls, and at each side of openings and corners. Position studs in tracks at floor and ceiling. Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.
- .5 Erect metal studding to tolerance of 1:1000.
- .6 Attach studs to bottom and/or ceiling track using screws.
- .7 Coordinate simultaneous erection of studs with installation of service lines. Align web openings when erecting studs.
- .8 Coordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .9 Provide two (2) studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together, **50** mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.
- .10 Install heavy gauge single jamb studs at openings.
- .11 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs.
 - .1 Secure track to studs at each end, in accordance with manufacturer's instructions.
 - .2 Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .12 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .13 Provide 40 mm stud or furring channel secured between studs for attachment of fixtures behind lavatory basins, toilet and bathroom accessories, and other fixtures including grab bars and towel rails, attached to steel stud partitions.
- .14 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .15 Extend partitions to ceiling height except where noted otherwise on Drawings.
- .16 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs. Use double track as indicated.
- .17 Install continuous insulating strips to isolate studs from uninsulated surfaces.
- .18 Install two (2) continuous beads of acoustical sealant insulating strip under studs and tracks around perimeter of sound control partitions.

3.3 CLEANING

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .3 Waste Management:
 - .1 Separate waste materials in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 **PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by non-structural metal framing application.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Porcelain tiling.
- .2 Crack isolation membrane.
- .3 Tile accessories.
- .4 Thinset mortar and grout.
- .5 Floor levelling.

1.2 **SYSTEM DESCRIPTION**

- .1 Porcelain tile, installed on floors, including base and using thinset application method.

1.3 **PERFORMANCE REQUIREMENTS**

- .1 Tile products manufactured and tested to ANSI A137.1.
- .2 Slip Resistance: Minimum dynamic coefficient of friction (DCOF) of 0.42 wet and dry to ANSI A137.1.
- .3 Floor Traffic Load Bearing Performance:
 - .1 ASTM C627, with the load ratings as indicated on Drawings:
 - .2 Extra Heavy, passing cycles 1 through 14.
- .4 Surface Flatness Tolerances: Large Format Floor Tile 1'-4" x 1'-4" and larger: Floor flatness measured to a minimum of FF50, equivalent to 1/8" with maximum two (2) gaps under 10'-0" straightedge measurement.

1.4 **ADMINISTRATIVE REQUIREMENTS**

- .1 Section 01 31 19 - Project Meetings.
- .2 Coordination:
 - .1 Coordinate with other work having a direct bearing on Work of this section.
 - .2 Coordinate requirements for floor recesses, accounting for thinset and tile thickness where finished tile surfaces are installed flush with adjacent floor finishes.
- .3 Pre-installation Meetings:
 - .1 Convene one (1) week before starting Work of this section.
 - .2 Attendance required by tile installer, Contractor, Consultant, mortar and grout representative to discuss subsurface flatness, installation techniques, material compatibility and site conditions.

1.5 **SUBMITTALS FOR REVIEW**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's product data for each type of product specified.
- .3 Shop Drawings: Indicate movement joints, transitions and intersections with dissimilar materials, color arrangement, tile layout, patterns and edging details.

- .4 Samples for Initial Selection: Submit the following samples for initial selection:
 - .1 Tile: Submit samples of actual tiles or sections of tiles showing manufacturer's full range of colors, textures, and patterns available for each type and composition of tile indicated. Include samples of accessories involving color selection.
 - .2 Grout: Manufacturer's standard colors using actual sections of grout showing full range of colors available for each type of grout indicated.
- .5 Submit the following samples for final verification, including full range of color and texture variations expected:
 - .1 Tiles: Submit two (2) pieces of each tile specified.
 - .2 Trims: Submit full size units of each type of trim and accessory in each color required for installation; minimum 6" lengths.
 - .3 Mount specified material including colored grout on ¾" thick plywood backer, 2'-0" x 2'-0" in size illustrating pattern, color variations, and grout joint size variations. Include perimeter accessories, movement joints, and trims where applicable.

1.6 SUBMITTALS FOR INFORMATION

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Manufacturer's Certificate: Certify that Products meet or exceed the requirements of ANSI A137.1.
- .3 Installation Data:
 - .1 Manufacturer's recommended and special installation requirements.
 - .2 Written instructions for using adhesives and grouts.

1.7 CLOSEOUT SUBMITTALS

- .1 Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: Submit two (2) copies of Terrazzo, Tile & Marble Association of Canada (TTMAC) Maintenance Guide and additional information as follows:
 - .1 Manufacturer's maintenance data sheets for floor sealers and other non-tile maintenance materials and accessories.
 - .2 Warning of maintenance practices or materials that may damage or disfigure finished Work.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- .1 Section 01 78 40 - Maintenance Requirements: Maintenance and extra material requirements.
- .2 Extra Stock Materials:
 - .1 Provide 2% of total of each size, color, and surface finish of tile specified.
 - .2 Store in original containers, clearly marked to identify the following:
 - .1 Manufacturer and distributor's name.
 - .2 Material series name and stocking number.
 - .3 Material description, including color and pattern.

1.9 QUALITY ASSURANCE

- .1 Products of this Section: Manufactured to ISO 9000 certification requirements.
- .2 Conform to TTMAC Manual.
- .3 Maintain one (1) copy of document on site.
- .4 Quality Assurance Program: Provide specifications and material compatibility submissions to TTMAC as required for Verispec Program; include costs for Verispec Program as part of submitted Bid.
- .5 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years documented experience.
- .6 Installer Qualifications: Company specializing in performing the Work of this section with minimum five (5) years documented experience and having completed tile installations similar in material, design and extent to this Project and be a member in good standing with TTMAC at time of bidding.

1.10 MOCK-UP

- .1 Section 01 40 00 - Quality Requirements: Provide mock-up of tile.
- .2 Dry lay sample installation for each form of construction and finish required.
- .3 Locate where directed by Consultant.
- .4 Accepted mock-ups will form the standard of acceptance for the remainder of the Work.
- .5 Approved mock-up may not remain as part of the Work.

1.11 DELIVERY, STORAGE AND PROTECTION

- .1 Section 01 61 00 - Product Requirements: Transport, handle, store and protect products.
- .2 Deliver and store packaged materials in original containers with seals unbroken and labels intact.
- .3 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 raised off floor and ground surfaces.

1.12 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Apply tile after completion of Work by other sections, to dry, clean, firm, level and plumb surfaces, free from oil or wax or any other material detrimental to tile adhesion.
 - .2 Maintain tile materials and substrate temperature between TTMAC recommended minimum and maximum temperature range.
 - .3 Maintain temperature range for minimum forty-eight (48) hours before and during installation and until materials are fully set and cured to manufacturer's recommendations.
 - .4 Maintain adequate ventilation where Work generates toxic gases or where there is a risk of raising relative humidity to levels detrimental to building finishes and assemblies.

Part 2 Products

2.1 **MANUFACTURER**

.1 Basis of Design:

- .1 Tiles as manufactured by Crossville Inc. <https://www.crossvilleinc.com>.
- .2 Substitutions: Not permitted.

2.2 **TILE MATERIALS**

.1 Floor Tile: ANSI A137.1, described as follows:

- .1 Composition: Porcelain.
- .2 **PT-1:**
 - .1 Tile: "Moonstruck".
 - .2 Number: AV303.
 - .3 Finish: UPS.
 - .4 Colour: Kosmos.
 - .5 Size: 1'-0" x 2'-0".
- .3 **PT-2:**
 - .1 Tile: "Moonstruck".
 - .2 Number: AV302.
 - .3 Finish: UPS.
 - .4 Colour: Luna.
 - .5 Size: 1'-0" x 2'-0".
- .4 Forming Method: Extruded.
- .5 Chemical Resistance: Pass Rating to ISO 10545.
- .6 Slip Resistance: Required.

2.3 **TRIMS AND EDGING**

.1 Trims:

- .1 Shapes and profiles to match color and finish of adjoining, coordinate with size and coursing of adjoining flat tile where applicable.
- .2 Base: Coved, to match flooring for surface finish and color:
 - .1 Length of units: As indicated on the Drawings.
 - .2 Height: As indicated on the Drawings.
 - .3 Top Edge: Bull nosed.
 - .4 Internal corners coved.
 - .5 External corner bullnosed.
- .2 Straight Edge and Transition Strips: Edge strips, shape; height as required to suit tile installation; with integral perforated anchoring leg. As indicated on the Drawings.

- .3 Reducer Strips: Purpose made metal extrusion; maximum slope of 1:2 as indicated on the Drawings.
- .4 Prefabricated Movement Joints: Purpose made, Shore A Hardness minimum 35, elasticity +/- 25% when used to TTMAC Manual.

2.4 MORTAR AND GROUT MATERIALS

- .1 Mortar Bed Materials:
 - .1 Portland Cement: CSA-A3000, Type GU.
 - .2 Hydrated Lime: ASTM C207, Type S N NA SA.
 - .3 Sand: ASTM C144, passing 16 mesh.
 - .4 Latex Additive: As approved.
 - .5 Potable water.
- .2 Floor Tile Mortar:
 - .1 Latex-Portland Cement (interior thin set):
 - .1 ANSI A118.4, fast-setting mortar with bond enhancing latex/polymer additives, rated for floor traffic load bearing performance as indicated.
 - .2 Product: As manufactured by Mapei Inc. <https://www.mapei.com/ca/en-ca/home>.
 - .3 Substitutions not permitted.
- .3 Tile Grout:
 - .1 Epoxy Grout:
 - .1 ANSI A118.3, water cleanable, chemical resistant, factory blended modified portland cement compound with epoxy additives and hardeners.
 - .2 Colour: As selected from manufacturer's full color range.
 - .3 Product: As manufactured by Mapei Inc.
 - .4 Substitutions not permitted.

2.5 ACCESSORIES

- .1 Crack Isolation:
 - .1 ANSI A118.12, corrugated polyethylene membrane with anchoring webbing system, thickness as recommended by manufacturer to accommodate in-plane substrate movement.
 - .2 Product As manufactured by Schluter Systems Canada Inc. <https://www.schluter.com>.

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Examine surfaces and verify that surfaces are ready to receive tile installation.

- .1 Concrete substrates have cured minimum of ninety (90) days to TTMAC requirements.
- .2 Substrates are dry; clean; free from oil, waxy films, and curing compounds; and within starting flatness tolerances and are ready for application of levelling materials.
- .3 Grounds, anchors, recessed frames, electrical and mechanical units of Work in or behind tile have been installed.
- .4 Joints and cracks in tile substrates are coordinated with tile joint locations.
- .3 Verify tile subject to color variations has been factory blended and packaged. If not factory blended, blend tiles at site before installing.

3.2 **PREPARATION**

- .1 Protect surrounding work from damage or disfiguration.
- .2 Vacuum clean surfaces and damp clean.
- .3 Seal substrate surface cracks with filler. Level existing substrate surfaces to flatness tolerances specified.

3.3 **INSTALLATION**

- .1 Install tile to TTMAC Manual.
- .2 Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- .3 Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions:
- .4 Cut and fit tile tight to penetrations through tile. Form corners and bases neatly. Align base and floor joints.
- .5 Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar or grout.
- .6 Adjust tile layout to minimize tile cutting. Maintain minimum tile width of one-half (½) unit size unless indicated otherwise on Drawings.
- .7 Form internal angles coved and external angles bullnosed.
- .8 Sound tile after setting. Replace hollow sounding units.
- .9 Keep control and expansion joints free of adhesive or grout.
- .10 Allow tile to set for a minimum of forty-eight (48) hours prior to grouting.
- .11 Install grout to TTMAC Manual and manufacturer's written instructions.
- .12 Apply sealant to junction of tile and dissimilar materials and planes.
- .13 Install prefabricated edge strips and movement joints at locations indicated or where exposed edge of floor tile meets different flooring materials and exposed substrates.
- .14 Protect exposed edges of floor tile with properly sized transition strips; at uneven transitions between ¼" and ½", use sloped reducer strips.

3.4 **INSTALLATION - ACCESSORIES**

- .1 Membranes: Install membrane to ANSI A108 series standards and manufacturer's written instructions; lap and seal watertight edges and ends.

- .2 Movement Joints: Install expansion and control joints where indicated on Drawings, to TTMAC Detail 301MJ-2012/2013 keep control and expansion joints free of setting and grouting materials.

3.5 **LIPPAGE TOLERANCES**

- .1 Field Verification of Finished Installation: To TTMAC Manual lippage limits as follows:

TILE TYPE	TILE SIZE	JOINT WIDTH	ALLOWABLE LIPPAGE
Pressed Floor/Porcelain	All	Maximum 1/8" (3 mm)	0.03" (0.78 mm)

3.6 **FIELD QUALITY CONTROL**

- .1 Section 01 40 00 - Quality Requirements: Field inspection.
- .2 Provide inspection of the following:
- .1 Tiles are set flush and level with adjacent tiles, meeting lippage requirements.
 - .2 Identify broken, cracked, damaged or hollow sounding tiles.
 - .3 Accessories are correctly installed.
 - .4 Grouting and sealant are correctly installed.
 - .5 Installation is complete to TTMAC.

3.7 **CLEANING**

- .1 Section 01 74 00 - Cleaning and Waste Processing: Cleaning installed work.
- .2 Clean tile and grout surfaces with manufacturer's recommended cleaning methods.

3.8 **PROTECTION OF FINISHED WORK**

- .1 Section 01 78 40 - Maintenance Requirements: Protecting installed work.
- .2 Protect finished areas from traffic until setting materials have sufficiently cured to TTMAC requirements.
- .3 Protect finished floor areas from foot and wheel traffic from floors for a minimum of seventy-two (72) hours after completion of grouting.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Suspended metal grid ceiling system and perimeter trim.
- .2 Acoustic panels.
- .3 Acoustic insulation.

1.2 **COORDINATION**

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

1.3 **PREINSTALLATION MEETING**

- .1 Convene preinstallation meeting one week prior to beginning Work of this section and on-site installation, with contractor's representative and departmental representative Consultant other affected trades in accordance with Section 01 32 00 - Construction Progress Documentation - Critical Path Method (CPM) to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with work of other sections.
 - .4 Review manufacturer's installation instructions and warranty requirements.
 - .5 Review accepted shop drawings for installation requirements.

1.4 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's instructions, printed product literature and data sheets for acoustical suspension, acoustic panels, acoustic tiles and system accessories. Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit reflected ceiling plans for special grid patterns as indicated.
 - .2 Indicate lay-out, insert and hanger spacing and fastening details, splicing method for main and cross runners, location of access splines change in level details, access door dimensions, and locations and acoustical unit support at ceiling fixture and lateral bracing and accessories.
- .4 Delegated Design Submittals:
 - .1 Submit delegated design shop drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
 - .2 Indicate components and installation methods to conform to specified seismic design and construction requirements of Contract Documents and in general accordance with ASTM E580/E580M.
 - .3 Include supporting details, treatment of cross runners, main runners, and wall closures at terminal ends, suspension wire, lateral force bracing, light fixtures and services within the ceiling, seismic isolation joints and partition bracing.

- .5 Samples:
 - .1 Submit for review and acceptance of each component specified or necessary for complete installation. Include technical descriptive data.
 - .2 Submit duplicate samples of each component proposed for use in each type of ceiling suspension system.
 - .3 Submit duplicate 6" x 6" samples of each type of acoustical unit.

1.5 **CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit operation and maintenance data for acoustical suspension for incorporation into manual.
- .3 Submit final certificate from design professional responsible for delegated detail design of ceiling indicating conformity with accepted shop drawings.
- .4 Submit Contractor's sustainable design and construction verification in accordance with Section 01 33 00 - Submittal Procedures.

1.6 **MAINTENANCE MATERIALS**

- .1 Provide extra acoustical units in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide acoustical units amounting to 2% of gross ceiling area for each pattern and type of acoustical panel or tile, suspension system and trim required for project, minimum one (1) complete factory-sealed package of each.
- .3 Ensure extra materials are from same production run as installed materials.
- .4 Deliver extra materials for each type of acoustical unit in original unopened packages clearly identified, including colour and texture.
- .5 Deliver to client, upon completion of the Work of this section.

1.7 **CERTIFICATIONS**

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

1.8 **MOCK-UPS**

- .1 Construct mock-ups in accordance with Section 01 40 00 - Quality Requirements.
- .2 Construct mock-up 10 m² minimum of each type acoustical ceiling assembly including one inside corner and one (1) outside corner. Ceiling system mock-up to show basic construction and assembly, treatment at walls, recessed fixtures, splicing, interlocking, finishes, acoustical unit installation, seismic reinforcing.
- .3 Construct mock-up where directed.
- .4 Allow twenty-four (24) hours for inspection of mock-up by Consultant before proceeding with ceiling work.

- .5 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of the finished work.

1.9 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 flat, [off ground, indoors and in dry location] and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect acoustical ceiling panels suspension grid components from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Store extra materials required for maintenance, where directed by Consultant.
- .4 Waste Management and Disposal: Separate waste materials for reuse and recycling or disposal in accordance with Section 01 74 00 - Cleaning and Waste Management.

1.10 ENVIRONMENTAL REQUIREMENTS

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

Part 2 Products

2.1 DESIGN CRITERIA

- .1 Design Requirements:
 - .1 Heavy duty system to ASTM C635/ASTM C635M.
 - .2 Maximum deflection: 1/360th of span to ASTM C635/ASTM C635M deflection test.
- .2 Seismic design requirements: Design acoustical ceiling installation to resist effects of earthquake motions under seismic design conditions specified in Contract Documents. Provide components as necessary to implement design.

2.2 SUSTAINABLE REQUIREMENTS

- .1 Ecolabel certified
 - .1 Cellulose fibre with minimum 75% recycled content.
 - .2 Glass fibre with minimum 35% recycled content.
 - .3 Mineral fibre with minimum 35% recycled content.
- .2 Low VOC-emitting materials.

2.3 **ACOUSTICAL CEILING SUSPENSION**

- .1 Acoustical Ceiling Suspension system, non-fire rated, made up as follows:
 - .1 Directional exposed tee bar grid.
 - .2 Directional concealed tee spline.
 - .3 Concealed tee access spline.
 - .4 Concealed tongue and groove runner.
 - .5 Concealed H runner, tee spline and flat steel spline.
 - .6 Concealed zee runner and flat steel spline.
 - .7 Metal pan special tee system.
- .2 Basic materials for suspension system: commercial quality cold rolled steel.
- .3 Exposed tee bar grid components: shop painted as indicated on the Drawings. Components die cut. Main tee with double web, rectangular bulb and 25 mm rolled cap on exposed face. Cross tee with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection.
- .4 Hanger wire: galvanized soft annealed steel wire:
 - .1 3.6 mm diameter for access tile ceilings.
 - .2 To ULC design requirements for fire rated assemblies.
 - .3 2.6 mm diameter for other ceilings.
- .5 Hanger inserts: purpose made.
- .6 Carrying channels: Size and finish as indicated on the Drawings.
- .7 Accessories: splices, clips, wire ties, retainers and wall molding to complement suspension system components, as recommended by system manufacturer.
- .8 Seismic components and accessories: in accordance with accepted Shop Drawings.

2.4 **ACOUSTICAL CEILING PANELS**

- .1 Acoustic Panels (APC-1 and APC-2): Manufacturers, colours, finishes etc., as indicated on the Drawings.
 - .1 Ceiling Attenuation Class (CAC) rating, in accordance with ASTM E1414.
 - .2 Light Reflectance (LR) range to ASTM E1477.
 - .3 Edge type as indicated on the Drawings.
 - .4 Colour as indicated on the Drawings.
 - .5 Sizes as indicated on the Drawings.
 - .6 Shape as indicated on the Drawings.
 - .7 Surface finish of aluminum panels: anodized.
 - .8 Fire-resistance rated, certified for use in floor/ceiling and roof/ceiling assembly.

2.5 **ACCESSORIES**

- .1 Fibrous acoustical media: to CAN/ULC-S702, without spacers, flame spread rating and smoke developed rating to CAN/ULC-S102.

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

Part 3 Execution

3.1 **EXAMINATION**

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

3.2 **INTERFACE WITH OTHER WORK**

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

3.3 **SUSPENSION SYSTEM INSTALLATION**

- .1 Comply with manufacturer's written installation instructions and recommendations, including product technical bulletins, product carton installation instructions and data sheets.
- .2 Install suspension system in accordance with accepted Shop Drawings, certification organizations tested design requirements and ASTM C636/C636M except where specified otherwise.
- .3 Lay out system according to reflected ceiling plan.
- .4 Finished ceiling system to be square with adjoining walls and level within 1:1000.
- .5 Secure hangers to overhead structure using attachment methods as indicated.
- .6 Install hangers spaced at maximum 1200 mm o.c. and within 6" from ends of main tees.
- .7 Ensure suspension system is coordinated with location of related components. Provide carrying channels as necessary to bridge at unavoidable interference between suspension system and other work above ceiling.
- .8 Install wall molding to provide correct ceiling height.
- .9 Completed suspension system to support super-imposed loads, such as lighting fixtures, diffusers, grilles and speakers.
- .10 Support at light fixtures diffusers with additional ceiling suspension hangers within 6" of each corner and at maximum 2'-0" around perimeter of fixture.
- .11 Attach cross member to main runner to provide rigid assembly.

- .12 Frame at openings for light fixtures, air diffusers, speakers and at changes in ceiling heights.
- .13 Install access splines to provide ceiling access as indicated on the Drawings.
- .14 Expansion joints:
 - .1 Erect two (2) main runners parallel, on building expansion joint line. Lay in strip of acoustic tile/board, 25% narrower than space between 2 'T' bars.
 - .2 Supply and install "Z" shaped metal trim pieces at each side of expansion joint. Design to accommodate plus or minus 25 mm movement and maintain visual closure. Finish metal components to match adjacent exposed metal trim. Provide backing plates behind butt joints.
- .15 Install perimeter trim at floating installations securely anchored to suspension system, in accurate alignment with adjacent assemblies. Install curved trim members in smooth curves to radius indicated.

3.4 **ACOUSTICAL CEILING PANEL INSTALLATION**

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

3.5 **SITE QUALITY CONTROL**

- .1 Arrange for periodic site visits by design professional responsible for delegated ceiling design work to review installed work for conformity to design.
- .2 Arrange for periodic site visits by manufacturer's representative to review installed work for conformity to manufacturer's installation instructions and recommendations.
- .3 Submit written site reports by designer to Consultant within three (3) days of visit.

3.6 **CLEANING**

- .1 Progress cleaning in accordance with Section 01 74 00 - Cleaning and Waste Management. Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management. Touch up scratches, abrasions, voids and other defects in painted surfaces.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 00 - Cleaning and Waste Management.

3.7 **PROTECTION**

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

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Thermoset-rubber base.
- .2 Rubber molding accessories.

1.2 **ACTION SUBMITTALS**

- .1 Product Data: For each type of product.
- .2 Samples: For each exposed product and for each color and texture specified, not less than 1'-0" long.
- .3 Samples for Initial Selection: For each type of product indicated.
- .4 Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 1'-0" long.
- .5 Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.3 **MAINTENANCE MATERIAL SUBMITTALS**

- .1 Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- .2 Furnish not less than 10'-0" for every 500'-0" or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 **QUALITY ASSURANCE**

- .1 Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - .1 Coordinate mockups in this Section with mockups specified in other sections.
 - .2 Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Consultant specifically approves such deviations in writing.
 - .3 Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 10°C or more than 32°C.

1.6 **FIELD CONDITIONS**

- .1 Maintain ambient temperatures within range recommended by manufacturer, but not less than 21°C or more than 35°C in spaces to receive resilient products during the following periods:
 - .1 Forty-eight (48) hours before installation.
 - .2 During installation.

- .3 Forty-eight (48) hours after installation.
 - .2 After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **13°C** or more than **35°C**.
 - .3 Install resilient products after other finishing operations, including painting, have been completed.
- Part 2 Products
- 2.1 **PERFORMANCE REQUIREMENTS**
- .1 Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- 2.2 **THERMOSET-RUBBER BASE (RB-3)**
- .1 Manufacturers: Subject to compliance with requirements, provide products by Johnsonite; A Tarkett Company.
 - .2 Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
 - .3 Style and Location: As indicated on the Drawings.
 - .4 Thickness: 1/8".
 - .5 Height: As indicated on Drawings.
 - .6 Lengths: Coils in manufacturer's standard length.
 - .7 Outside Corners: Preformed.
 - .8 Inside Corners: Preformed.
 - .9 Colors: As indicated by manufacturer's designations.
- 2.3 **INSTALLATION MATERIALS**
- .1 Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
 - .2 Adhesives:
 - .1 Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - .2 Adhesives shall have a VOC content of 50 g/L or less and 60 g/L or less for rubber stair treads.
 - .3 Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.
 - .4 Metal Edge Strips: Extruded aluminum with mill finish nominal 2" wide of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- .2 Verify that finishes of substrates comply with tolerances and other requirements specified in other sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.
- .4 Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 **PREPARATION**

- .1 Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- .2 Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces.
- .3 Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- .4 Do not install resilient products until materials are the same temperature as space where they are to be installed.
- .5 At least forty-eight (48) hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- .6 Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 **RESILIENT BASE INSTALLATION**

- .1 Comply with manufacturer's written instructions for installing resilient base.
- .2 Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- .3 Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- .4 Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- .5 Do not stretch resilient base during installation.
- .6 On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- .7 Preformed Corners: Install preformed corners before installing straight pieces.

3.4 **RESILIENT ACCESSORY INSTALLATION**

- .1 Comply with manufacturer's written instructions for installing resilient accessories.
- .2 Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- .1 Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- .2 Perform the following operations immediately after completing resilient-product installation:
 - .1 Remove adhesive and other blemishes from surfaces.
 - .2 Sweep and vacuum horizontal surfaces thoroughly.
 - .3 Damp-mop horizontal surfaces to remove marks and soil.
- .3 Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- .4 Floor Polish:
 - .1 Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.
 - .2 Apply two (2) coat(s).
- .5 Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Resilient sheet flooring.

1.2 **ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination: Upon request, Consultant will make available a digital drawing file of the floor finish plan illustrating complex.
- .2 Pre-installation Meetings:
 - .1 When requested by Consultant, arrange a meeting in accordance with Section 01 31 19 – Project Meetings. Discuss substrate.
 - .2 Review National Floor Covering association (NFCA) Quality Assurance Program (QAP) Inspection procedures and reports and timing of reports for multi-phase projects.
- .3 Sequencing: Install flooring after painting and ceiling work is complete.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's instructions, product literature and data sheets for resilient sheet flooring and accessories. Include product characteristics, performance criteria, dimensions, finishes and limitations.
- .3 Samples for Initial Selection: Submit the following for Consultant's initial selection of colours:
 - .1 300 x 300 mm samples of each type of resilient sheet flooring
 - .2 Samples of sheet flooring welding beads
 - .3 Samples of accessories where exposed to view
- .4 Samples for Verification: Submit before constructing mock-up duplicate 300 x 300 mm sample pieces of sheet material.
- .5 Site Quality Control Submittals:
 - .1 Submit floor substrate test results prior to beginning flooring installation. Include comparison of sheet flooring manufacturer's acceptable alkaline level and recommended maximum moisture emission rates to site test results for each type of flooring.
 - .2 Submit information in accordance with NFCA QAP procedures and requirements. Submit inspection results and reports for review. When deviations from specified physical conditions or performance criteria are found, Do not proceed without written acceptance of Consultant.

1.4 **CLOSEOUT SUBMITTALS**

- .1 Operations and Maintenance Data: Submit manufacturer's cleaning and repair recommendations in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Warranty Documentation: Submit manufacturer's warranties.
- .3 Bonds: Submit floor covering Subcontractor's two (2) year maintenance bond for 100% value of this work.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials: Supply extra materials in accordance with Section 01 78 00 - Closeout Submittals and as follows:
 - .1 Supply 2% of each colour, pattern and type of flooring material in full roll width for maintenance use. Also supply sheet flooring off-cuts where size is 450 x 450 mm or larger.
 - .2 Supply extra materials in one (1) piece and from the same production run as installed materials.
 - .3 Label each roll of sheet flooring [and each container of adhesive].

1.6 QUALITY ASSURANCE

- .1 Preparation, materials and workmanship in accordance with NFCA QAP requirements. Repair or replace deficient work in accordance with NFCA QAP requirements.
- .2 Installers: Experienced in resilient sheet flooring, welding bead seaming with five (5) years documented successful installations with manufacturer's training or certification program.
- .3 Third-Party Independent Inspector Qualifications: Assigned by a NFCA Accredited QAP provider.
- .4 Mock-Ups: Construct mock-up in accordance with Section 01 40 00 - Quality Requirements and as follows:
 - .1 Construct a mock-up of resilient sheet flooring including a flooring seam.
 - .2 Acceptable mock-up may remain as part of the completed work.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Perform in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, with manufacturer's labels.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in a clean dry location and in accordance with manufacturer's recommendations in well-ventilated area.
 - .2 Protect adhesives, fillers and sealants from freezing.
 - .3 Store and protect materials from nicks, scratches and blemishes.
- .4 Packaging Waste Management: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.

1.8 SITE CONDITIONS

- .1 Ambient Conditions: For seventy (72) hours before installation, continuously during and seventy (72) hours after installation, maintain the following conditions, except when manufacturer's recommendations are more stringent:
 - .1 Ambient room temperature: 18 to 29°C
 - .2 Floor substrate temperature: minimum 15°C

.3 Relative humidity: 40 to 60%

Part 2 Products

2.1 **REGULATORY REQUIREMENTS**

- .1 Meet requirements of CAN/ULC S102.2 for required flame spread ratings labelled and listed by ULC Standards or another agency acceptable to authorities having jurisdiction (AHJ).

2.2 **PERFORMANCE CRITERIA**

2.3 **MATERIALS**

- .1 Sheet Vinyl Without Backing to ASTM F1913 and as follows:

.1 Basis-of-Design Product:

- .1 Subject to compliance with requirements, provide; "iQ Optima" as manufactured by the Tarkett Company <https://commercial.tarkett.ca>.

- .2 Substitutions not permitted.

- .2 Sheet Standard: ASTM F1913, Standard Specification for Vinyl Sheet Floor Covering Without Backing.

- .3 Thickness/Wearlayer: 0.08" (2 mm).

- .4 Size: 6'-6" (2 m).

- .5 Colors and Patterns: As indicated on the Drawings.

.6 Test Data:

- .1 Flexibility (ASTM F137): Passes.
.2 Chemical Resistance (ASTM F925): Passes.
.3 Static Load Limit (ASTM F 970): Passes 250 psi.
.4 Resistance to Heat (ASTM F1514): $\Delta E \leq 8$.
.5 Resistance to Light (ASTM F1515): $\Delta E \leq 8$.
.6 Residual Indentation (ASTM F1914): Passes.
.7 Static Coefficient of Friction (SCOF) (ASTM D 2047): ≥ 0.5 SCOF.
.8 Flammability (ASTM E648, Critical Radiant Flux): Class 1 (≥ 0.45 W/cm²).

2.4 **ACCESSORIES**

- .1 Primer: Where recommended by sheet flooring manufacturer for site conditions and application.

- .2 Concrete Moisture Emission Reducer: Moisture insensitive, epoxy modified, forming a permanent moisture barrier, water vapour permeability less than 6 ng/Pa·s·m² (0.1 perms) when tested to ASTM E96 (wet method), other test methods will be considered.

- .3 Adhesives:

- .1 Types recommended by flooring manufacturer for substrate, above, on or below grade.

- .2 Cove base adhesives: Type recommended by base manufacturer to suit application.
- .3 Static conductive flooring adhesive: Full spread adhesive, specially formulated for static conductive flooring and as recommended by sheet flooring manufacturer for application.
- .4 Sub-floor Filler and Leveler: As recommended by sheet flooring manufacturer.
- .5 Heat Welding Bead:
 - .1 Solid strand product, recommended by sheet flooring manufacturer for heat welding seams and as follows:
 - .2 Colour and pattern: Matching colour and pattern of resilient flooring.
- .6 Metal Transition and Edge Strips:
 - .1 Meeting CSA B651 for height and slope, as indicated on the Drawings and with lip to extend under sheet flooring, shoulder flush with top of adjacent floor finish.
 - .2 Colour: As indicated on finish schedule.
- .7 Resilient Transition and Edge Strips:
 - .1 Meeting CSA B651 for height and slope, extruded aluminum.
 - .2 Colour: As indicated on finish schedule.
- .8 Edging at Floor Penetrations: Type recommended by flooring manufacturer.
- .9 Sealer: If recommended by sheet flooring manufacturer, type recommended by manufacturer.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Verification of Conditions:
 - .1 Verify that substrate conditions are clean, free of cracks, ridges, depressions, scale, foreign materials and acceptable for resilient sheet flooring installation in accordance with manufacturer's instructions.
 - .2 Proceed with installation only after unacceptable conditions are remedied.
- .3 Pre-installation Testing:
 - .1 Perform tests to verify concrete floors are dry, with low moisture vapour emission rate and low alkalinity. Perform tests to ASTM F2170 or ASTM F1869, except where sheet flooring manufacturer recommends more stringent test methods and requirements. Notify Consultant of testing date so they may choose to attend at their discretion.
 - .2 Moisture Vapour Emissions: Perform one (1) test per floor area.
 - .3 pH range: 7 to 9. Perform one (1) test per floor area.
 - .4 Perform adhesive bond test to cleaned concrete substrate, 1 x 1 m, allow to cure for seventy-two (72) hours before evaluating bond strength.

3.2 PREPARATION

- .1 If concrete floor substrate vapour emissions exceed manufacturer's recommendations, prepare substrate in accordance with ASTM F3010.
- .2 Prepare concrete floor substrates to ASTM F710.
- .3 Remove subfloor ridges and bumps.
- .4 Clean floor of dust, mould, mildew, alkaline salts, laitance, concrete film-forming curing compounds, paint, solvents, wax, oil, grease, residual adhesive, adhesive removing compounds, sealants, soap and other foreign material.
- .5 Fill low spots, cracks, joints, holes and other defects with sub-floor filler. Trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler is dry and cured.
- .6 [Prime or seal concrete slab] to resilient flooring manufacturer's recommendations.
- .7 Do not use permanent markers on floor substrates.

3.3 INSTALLATION - FLOORING

- .1 Provide high ventilation rate maximizing outside air during installation and for forty-eight (48) to seventy-two (72) hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through building air distribution system. Maintain extra ventilation for at least one (1) month following building occupation.
- .2 Apply adhesive uniformly using manufacturer's recommended trowel, followed by a roller or similar tool to knock down trowel ridges and eliminate them from telegraphing through finished flooring. Do not spread more adhesive than can be covered by sheet flooring before initial set takes place.
- .3 Lay flooring with seams in directions indicated on Drawings to produce a minimum number of seams. Border widths shall be a minimum one third (1/3) the width of full material.
- .4 Double cut sheet joints and continuously heat weld according to manufacturer's instructions.
- .5 Do not install flooring over building expansion joints.
- .6 As installation progresses, and after installation roll sheet flooring with a minimum 45 kg roller or other weight where indicated in manufacturer's installation recommendations, for full adhesion and to expel air bubbles.
- .7 Promptly remove excess adhesive.
- .8 Cut flooring neatly around fixed objects.
- .9 Install feature strips and special patterns where indicated. Fit joints tightly.
- .10 Install sheet flooring continuously in areas which will be under built-in furniture.
- .11 Terminate flooring under centreline of door, in openings where adjacent floor finish materials or colours are dissimilar.
- .12 Install metal edge strips at unprotected and exposed edges where sheet flooring terminates.

3.4 SITE QUALITY CONTROL

- .1 Site Inspections: Third-party independent inspection agency: Provide services of a NFCA accredited third-party independent inspection agency to conduct random inspections and issue reports before, during and after installation of floor covering. Inspections and reports in accordance with NFCA QAP - Part A04.
- .2 Manufacturer's Site Services:
 - .1 Mock-Ups: Manufacturer to submit written confirmation that resilient sheet flooring installed meets or exceeds product requirements.
 - .2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, protecting and initial cleaning of product and submit Manufacturer's Site Reports.
 - .3 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 For resilient flooring materials or systems, the manufacturer's representative shall review surfaces and conditions for material applications and provide sufficient site reviews and reports to ensure installation conforms with the product warranty requirements.

3.5 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .2 Final Cleaning:
 - .1 Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Clean flooring base surfaces to manufacturer's recommendations.
- .3 Waste Management: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.

3.6 PROTECTION

- .1 Prohibit traffic on floor for a minimum of forty-eight (48) to seventy-two (72) hours after installation. Protect new floors until adhesive is fully cured after initial waxing after initial sealer is applied.
- .2 Where flooring areas will receive heavy traffic, rolling loads or pallet jacks, protect flooring with 6 mm thick temporary hardboard panels. Sweep or vacuum under panel areas prior to placement.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Solid vinyl floor tile.

1.2 **ADMINISTRATIVE REQUIREMENTS**

.1 Coordination:

- .1 Coordinate floor substrate preparation with Section 02 41 19.16 - Selective Interior Demolition. Demolition may include mechanical or chemical removal of existing floor coverings, adhesives, sealers, paint, curing agents and other surface contaminants. Verify after demolition is complete, that substrates are suitable to begin work of this Section.

- .2 Coordinate door thresholds with Section 08 71 00 - Door Hardware.

- .2 Pre-Installation Meetings: Conduct a meeting approximately two (2) weeks before pouring concrete with the Contractor, resilient flooring Subcontractor, flooring manufacturer's representative, **and** Consultant in accordance with Section 01 31 19 – Project Meetings to discuss the following:

- .1 Review substrate conditions including substrate flatness and levelness.
- .2 Substrate test results for moisture content, water vapour emissions, alkalinity, bond strength and porosity.
- .3 Special coordination with other Subcontractors.
- .4 Review manufacturer's installation instructions and warranty requirements.
- .5 Mock-up requirements.
- .6 Review National Floor Covering Association (NFCA) inspection procedures and reports and timing of reports for multi-phase projects.

- .3 Sequencing: Install flooring after painting, ceiling work and other overhead work are complete.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Product Data: Submit manufacturer's product literature, data sheets and Workplace Hazardous Materials Information System (WHMIS) safety data sheets for resilient tile flooring, preparation materials and accessories. Include Product characteristics, performance criteria, physical sizes, finishes and limitations.

- .3 Shop Drawings: Submit Shop Drawings indicating the following:

- .1 Each resilient floor tile type, installation method, locations of building movement joints.
- .2 Drawing details of stair treads, risers and landings.
- .3 Locations and types of edge strips and reducer strips at flooring penetrations.

- .4 Samples for Initial Selection: Submit the following for Consultant's selection of colours:

- .1 Full-size samples of each type of resilient tile flooring.
- .2 Small samples of resilient base.
- .3 Samples of accessories where exposed to view.

- .5 Samples for Verification: Submit duplicate full-size samples of resilient tile flooring and 1'-0" long reducer strips and edge strips.
- .6 Test and Evaluation Reports: Submit floor substrate test results before beginning resilient tile flooring installation. Include a comparison to the resilient flooring manufacturer's minimum acceptable conditions.
- .7 Manufacturer's Instructions: Submit manufacturer's storage, handling and installation instructions.
- .8 Site Quality Control Submittals:
 - .1 Submit in accordance with National Floor Covering Association (NFCA) Quality Assurance Program (QAP) procedures and requirements.
 - .2 Submit inspection results and reports as described herein.
- .9 Manufacturer Reports: Submit manufacturer's reports within [three (3)] days of review, verifying compliance of installed resilient tile flooring as described herein.
- .10 Qualification Statements:
 - .1 When requested by Consultant, submit a list of installer's similar projects completed within the last two (2) years.
 - .2 Submit resilient tile flooring manufacturer's declaration that flooring materials are compatible, when requested.

1.4 **CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: Submit maintenance, repair and cleaning recommendations for resilient tile flooring and incorporate into manual.
- .3 Record Documentation: Submit a list of materials installed, including adhesives, wall base and accessories. Indicate manufacturers, products, types, patterns and colour names and numbers. Indicate room/area where installed.
- .4 Bonds: Floor covering Subcontractor to provide a 100% two (2) year maintenance bond.

1.5 **MAINTENANCE MATERIAL SUBMITTALS**

- .1 Operations and Maintenance Data: Submit manufacturer's cleaning and repair recommendations in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit Subcontractor's maintenance bond.
- .3 Warranty Documentation: Submit manufacturer's warranties.
- .4 Extra Materials:
 - .1 Supply extra materials for maintenance use in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Supply a minimum of one (1) box of each resilient tile type, pattern and colour installed or an area equal to 2 % of the area installed or a minimum 4 m² of each resilient tile, whichever is greater.
 - .3 Supply a minimum two (2) of the length installed of the resilient base in a continuous roll for each type, colour and height. Manufacturer's standard maximum lengths are acceptable instead of rolls.

- .4 Supply enough of each adhesive to install maintenance materials in manufacturer's standard containers.
- .5 Supply extra materials from same production run as installed materials.
- .6 Label each box of resilient floor tile, and each container of adhesive with manufacturer's name, product name and room/area where installed.

1.6 **QUALITY ASSURANCE**

- .1 Installer Qualifications:
 - .1 Five (5) years of experience and successful completion of five (5) projects of similarly installed area, materials and complexity.
 - .2 Member in good standing throughout the performance of the Work of National Floor Covering Association (NFCA) and Resilient Flooring Contractors Association of Ontario (RFCAO).
 - .3 Trade qualifications to NFCA Floor Covering Reference Manual of Canada.
 - .4 Apprentices are acceptable when under direct supervision of qualified journey person in accordance with applicable trade regulation.
- .2 Third-Party Independent Inspector Qualifications: A NFCA Accredited QAP provider recognized by NFCA inspection and reporting requirements.
- .3 Mock-ups:
 - .1 Assemble a mock-up in accordance with Section 01 43 00 – Quality Assurance.
 - .2 Mock-up Size: 600 x 600 mm of each resilient tile type flooring. Mock-up to demonstrate:
 - .1 Installation pattern.
 - .2 Installation workmanship at walls and doorways.
 - .3 Inside corner and outside corner of wall base.
 - .4 Edge strips and reducer strips.
 - .3 Subcontractor to attend review of mock-up.

1.7 **DELIVERY, STORAGE AND HANDLING**

- .1 Perform in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Storage and Handling Requirements:
 - .1 Store materials off ground indoors and in dry location and in clean, temperature controlled, well-ventilated area.
 - .2 Store and protect specified materials from nicks, scratches and blemishes.
 - .3 Coordinate delivery of materials with scheduled installation to allow minimum conditioning time on Project site.
- .3 Packaging Waste Management: Perform in accordance with Section 01 74 19 - Waste Management and Disposal.

1.8 **SITE CONDITIONS**

- .1 Unless otherwise stated in manufacturer's instructions, maintain Project site conditions to occupancy service conditions or according to requirements in NFCA Floor Covering Reference Manual for a minimum forty-eight (48) hours before installation, during installation and a minimum forty-eight (48) hours after installation. Project site conditions include:
 - .1 Ambient, substrate and material temperatures between 18°C and 29°C. Temperatures may be reduced to 13°C seventy-two (72) hours after installation.
 - .2 Subfloor surface temperature for adhesive application between 16°C and 29°C.
 - .3 Relative humidity (RH) between 40% and 60% with temperature at 18°C to 29°C.
- .2 Ventilation: Provide temporary ventilation where existing systems are not available or are inadequate to meet minimum requirements in accordance with Section 01 51 00 – Temporary Utilities and as follows:
 - .1 Provide high ventilation rate with maximum outside air 24 to 48 hours before, during installation and forty-eight (48) to seventy-two (72) hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through air distribution system. Continue high ventilation rate for at least four (4) weeks after building occupation.
 - .2 Coordinate operation of existing ventilation system with Consultant.

Part 2 Products

2.1 **REGULATORY REQUIREMENTS**

- .1 Meet requirements of CAN/ULC S102.2 for required flame-spread ratings, labelled and listed by Underwriters Laboratories of Canada (ULC) or another agency acceptable to authorities having jurisdiction (AHJ).

2.2 **PERFORMANCE CRITERIA**

- .1 Preparation, materials and workmanship in accordance with NFCA QAP requirements.

2.3 **RESILIENT TILE FLOORING MATERIALS**

- .1 Solid Vinyl Tile: To ASTM F1700 and as follows:
 - .1 Basis-of-Design Product: "Cortina Grande" as manufactured by Tarkett North America https://commercial.tarkett.ca/en_CA.
 - .2 Sheet Standard: ASTM F 1700, Class 1, Type A, Smooth surface.
 - .3 Thickness/Wearlayer: 1/8".
 - .4 For size specify: 1'-4" x 1'-4".
 - .5 Colors and Patterns: As selected by the Consultant from full range of manufacturers colours and patterns.
 - .6 Test data:
 - .1 Total thickness (ASTM F386): 0.08" (2 mm).
 - .2 Flexibility (ASTM F137): Passes.
 - .3 Chemical Resistance (ASTM F925): Passes.

- .4 Static Load Limit (ASTM F 970): Passes 250 psi / Modified 800 psi.
 - .5 Resistance to Heat (ASTM F1514): $\Delta E \leq 8$.
 - .6 Resistance to Light (ASTM F1515): $\Delta E \leq 8$.
 - .7 Residual Indentation (ASTM F1914): Passes.
 - .8 Size, Tolerance (ASTM F2055): Passes.
 - .9 Static Coefficient of Friction (ASTM D 2047): ≥ 0.5 SCOF.
 - .10 Flamability (ASTM E648, Critical Radiant Flux): Class 1 (≥ 0.45 W/cm²).
 - .11 Limited Commercial Warranty: Ten (10) years.
- .7 Colours: As indicated on Drawings and as selected by Consultant from manufacturer's complete range.

2.4 ACCESSORIES

- .1 Primer: Where recommended by sheet flooring manufacturer for site conditions and application.
- .2 Concrete Moisture Emission Reducer Coating: Moisture insensitive, epoxy modified, forming a permanent moisture barrier, water vapour permeability less than [6] ng/Pa-s-m when tested to ASTM E96/96M (wet method). Other test methods will be considered.
- .3 Adhesives: Tarkett 959 Vinyl Tile and Plank Adhesive.
- .4 Sub-floor Filler and Leveler: As recommended by flooring manufacturer for use with their Product.
- .5 Metal Transition and Edge Strips:
 - .1 Meeting CAN/CSA B651 for height and slope, with lip to extend under sheet flooring, shoulder flush with top of adjacent floor finish.
 - .2 Material and Colour: As selected by Consultant.
- .6 Edging to Floor Penetrations: Same material as typical edging strips, profile recommended by resilient tile flooring manufacturer.
- .7 Sealer: To CAN/CGSB-25.20, Type 2, water based and as recommended by resilient tile flooring manufacturer.
- .8 Wax: To CAN/CGSB-25.21 Type recommended by flooring manufacturer and compatible with finish materials used.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions:
 - .1 Verify that conditions of substrate previously installed are acceptable for resilient tile flooring installation in accordance with manufacturer's instructions.
 - .2 Verify concrete floors are free of cracks, ridges, depressions, scale, foreign materials, paint, varnish, dust, oils, release agents, waxes and sealers and that curing and hardening compounds have been removed.
 - .3 Verify substrate tolerances are within resilient tile flooring manufacturer's recommendations.

- .4 Verify concrete surface profile is within resilient tile flooring manufacturer's recommendations.
- .5 Verify that work by other Subcontractors affecting the flooring installation is acceptable.
- .6 Report defective conditions affecting installation to Consultant in writing immediately upon discovery and before beginning installation.
- .7 Proceed with installation only after defective surfaces and conditions have been remedied.
- .2 Pre-Installation Testing:
 - .1 Perform tests to verify concrete floors are dry, with moisture vapour emission rate and alkalinity within the manufacturer's recommendations. Perform tests to test methods in NFCA Floor Covering Reference Manual, except where resilient tile flooring manufacturer recommends more stringent test methods and requirements. Notify Consultant of testing date so they may choose to attend at their discretion.
 - .2 Perform tests before installation of subsequent products (hydraulic cement underlayment, fillers, patching materials, adhesives, etc.).
 - .3 Test substrate moisture vapour emissions to ASTM F710. Perform a minimum three (3) tests for the first 100 m² and one (1) additional test per 100 m² of additional floor area.
 - .4 Test substrate alkalinity to ASTM F710, pH range of 7 to 9. Perform one (1) test per 100 m² of floor area.
 - .5 Test substrate porosity to ASTM F3191.
 - .6 Perform adhesive bond test to cleaned concrete substrate in accordance with NFCA Floor Covering Reference Manual, unless otherwise recommended by floor covering manufacturer and allow to cure for seventy-two (72) hours before evaluating bond strength.

3.2 PREPARATION

- .1 Protection of In-Place Conditions: Protect face of doors, door frames and walls from marring due to installation of resilient tile flooring.
- .2 Surface Preparation: In accordance with NFCA Floor Covering Reference Manual, Part A13 and ASTM F710 for concrete floors, manufacturer's instructions and as follows:
 - .1 Remove or treat old adhesives to prevent residual, old flooring adhesives from bleeding through to new flooring and interfering with the bonding of new adhesives.
 - .2 Remove pen and marker lines completely from concrete surfaces.
 - .3 If concrete floor substrate vapour emissions exceed manufacturer's recommendations, prepare substrate in accordance with ASTM F3010.
 - .4 Remove subfloor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with subfloor filler.
 - .5 Where floor substrate flatness and levelness tolerances do not meet minimum requirements to begin installation of resilient tile flooring, prepare substrate in accordance with NFCA Floor Covering Reference Manual.

- .6 Clean floor of dust, mold, mildew, alkaline salts, laitance, concrete film-forming curing compounds, paint, solvents, wax, oil, grease, residual adhesive, adhesive removing compounds, sealants, soap and other foreign material.
- .7 Fill low spots, cracks, joints, holes and other defects with subfloor filler in accordance with ASTM F2873. Trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler is cured.
- .8 Prime concrete slab to resilient tile flooring and adhesive manufacturer's recommendations.
- .9 Vacuum substrates.
- .10 Do not use permanent markers on floor substrates.

3.3 **INSTALLATION – RESILIENT TILE**

- .1 Install resilient tile flooring and accessories using tools, materials, methods and sequence of work to NFCA Floor Covering Reference Manual recommendations and manufacturer's recommendations.
- .2 Mix and apply adhesive uniformly in accordance with manufacturer's instructions, using manufacturer-recommended trowel notching, spread, coverage rate, open times and safety precautions. Do not spread more adhesive than can be covered by flooring before initial set.
- .3 Lay flooring with joints parallel to building lines to produce symmetrical tile pattern. Border tiles minimum half tile width, but not less than 6" wide.
- .4 Install flooring to patterns indicated on Drawings.
- .5 Cut resilient tile and fit neatly around fixed objects.
- .6 Cut resilient tile to fit tightly in pan type floor access covers and to frames, using hardware cut-outs.
- .7 Install resilient tile flooring in areas which will be under built-in furniture.
- .8 Install resilient tile flooring through areas to receive movable type partitions without interrupting floor pattern.
- .9 Install resilient tile flooring through doorways and scribed to fit projections and vertical surfaces.
- .10 Terminate flooring under centreline of door, in openings where adjacent floor finish material or colour are dissimilar.
- .11 During and after installation, roll flooring in two (2) directions with minimum weighted roller to achieve full adhesion and prevent visible adhesive or trowel marks, unless otherwise indicated by flooring manufacturer.
- .12 Install edge strips at floor penetrations and edge strips at unprotected and exposed edges where flooring terminates to suit conditions. Securely bond to substrate and in a straight line.
- .13 When necessitated by material size, locate cross seams and seams at doors and pivot points in accordance with accepted Shop Drawings.
- .14 Apply waterproof sealant at edge of linoleum abutting walls, millwork bases and other projections in wet areas.

3.4 APPLICATION - FINISHES

- .1 Seal and wax floors to resilient tile flooring manufacturer's instructions.

3.5 SITE QUALITY CONTROL

- .1 Site Inspections: Provide services of a NFCA accredited independent inspection agency to conduct random inspections and issue reports before, during and after installation of floor covering. Inspections and reports in accordance with NFCA QAP - Part A04.
- .2 Manufacturer's Site Services:
 - .1 Provide manufacturer's site services consisting of periodic Project site visits to inspect Product installation in accordance with manufacturer's instructions.
 - .2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, protecting and initial cleaning of product and submit manufacturer's site reports.
 - .3 For specialty resilient flooring materials or systems, the manufacturer's representative shall review substrates and conditions for material applications and provide sufficient Project site reviews and reports to verify installation conforms with product warranty.

3.6 ADJUSTING

- .1 Repair or replace deficient work in accordance with NFCA QAP requirements.

3.7 CLEANING

- .1 Progress Cleaning: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management. Remove excess adhesive before cured.
- .2 Final Cleaning: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .3 Waste Management: Perform in accordance with Section 01 74 00 - Cleaning and Waste Management.

3.8 CLOSEOUT ACTIVITIES

- .1 Demonstration and Training:
 - .1 Perform in accordance with Section 01 79 00 – Demonstration and Training.
 - .2 Recommend cleaning and finishing Products to Owner to suit Project site conditions and application and that will not affect flooring slip-resistance.
 - .3 Demonstrate to Owner periodic cleaning methods for each resilient flooring type.

3.9 PROTECTION

- .1 Protect flooring with non-marring temporary coverings until Substantial Performance.
- .2 Prohibit traffic on resilient tile flooring for a minimum forty-eight (48) hours after installation.
- .3 Protect resilient tile flooring from heavy rolling loads during construction with plywood, hardboard or other protection method recommended by resilient tile flooring manufacturer.

- .4 Allow a minimum twenty-four (24) hours for Project site applied finishes to dry before permitting foot traffic and a minimum seven (7) days before placing furniture and similar heavy objects.
- .5 Protect cork flooring with heavy kraft paper or as otherwise recommended by cork flooring manufacturer. Do not cover cork flooring with materials that may cause condensation to form.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES:**

- .1 Thin-set, epoxy-resin terrazzo flooring.

1.2 **PREINSTALLATION MEETINGS**

- .1 Preinstallation Conference: Conduct conference at Project site.
 - .1 Review methods and procedures related to terrazzo including, but not limited to, the following:
 - .1 Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - .2 Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - .3 Review special terrazzo designs and patterns.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Provide Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Province, Canada.
 - .2 Indicate layout of divider strips and expansion joints.
- .4 Samples:
 - .1 Provide samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit duplicate, 305 x 305 x 6 mm thick samples of each colour of plastic matrix terrazzo.
- .5 Closeout Submittals: Provide maintenance data for plastic matrix terrazzo for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 **QUALITY ASSURANCE**

- .1 Installer Qualifications:
 - .1 Engage an installer who is a contractor member of NTMA.
 - .2 Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
- .2 Mockups:
 - .1 Construct mock-ups in accordance with Section 01 43 00 - Quality Assurance.
 - .2 Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - .3 Build mockups for terrazzo including accessories.
 - .4 Include base.

- .5 Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Consultant specifically approves such deviations in writing.
- .6 Construct mock-up 10 m² of each type of plastic matrix terrazzo including one inside corner, one outside corner, change of material, and door threshold,].
- .7 Construct mock-up where directed.
- .8 Allow twenty-four (24) hours for inspection of mock-up by Consultant before proceeding with ceiling work.
- .9 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of the finished work.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to job site just prior to installation.
- .3 Store materials inside, in dry location, away from heavy traffic areas.
- .4 Deliver and store materials in manner to prevent damage.
- .5 Ensure materials remain in original wrapping and containers until used.
- .6 Waste Management and Disposal: Separate waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 **ENVIRONMENTAL REQUIREMENTS**

- .1 Safety:
 - .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of materials.
 - .2 Respirators: worn by workers mixing epoxy.
- .2 Ventilation:
 - .1 Provided continuously during and after installation. Run system twenty-four (24) hours per day during installation; provide continuous ventilation for seven (7) days after completion of installation.
 - .2 Ventilate enclosed spaces.
- .3 Temperature: Maintain temperature and structural base temperature at plastic matrix terrazzo installation area above 12 degrees C for twenty-four (24) hours prior to, during, and for twenty-four (24) hours following installation.

1.7 **FIELD CONDITIONS**

- .1 Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.
- .2 Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.
- .3 Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

- .4 Close spaces to traffic during terrazzo application and for not less than twenty-four (24) hours after application unless manufacturer recommends a longer period.
- .5 Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

Part 2 Products

2.1 **MATERIALS**

- .1 Marble Chips:
 - .1 Uniform, sound and abrasion resistant.
 - .2 Glass chips: uniform, sound, abrasion resistant.
 - .3 Grade chips in accordance with TTMAC standard
- .2 Epoxy Matrix: Consisting of two (2) non-volatile components, epoxy resin and epoxy hardener, conforming to following performance properties after cure schedule of fourteen (14) days at **25** degrees C:
 - .1 Hardness: Method A, to ASTM D2240, **[85]** points.
 - .2 Tensile Strength: **28** MPa minimum **12** mm/minute using CDie (ASTM D412). Specimens to be cast not cut.
 - .3 Tensile Elongation: Test ASTM D638: 5% minimum **5** mm/minute using CDie.
 - .4 Compressive Strength: Test ASTM D695 specimen B, cylinder **80** MPa minimum.
 - .5 Linear Shrinkage: Test ERF-64, **0.04** mm maximum.
 - .6 Colour Retention: ASTM G23 Method A – forty-eight (48) hours. Colour 101-103
 - .7 Chemical Resistance: FTM Test 406, method 7011 – seven (7) days immersion.

Mineral oil	no effect
Oil ASTM No 3	no effect
Lard	no effect
Five (5) detergent	no effect
1% soap solution	no effect
Distilled water	no effect
Calcium chloride 10% solution	no effect

- .8 Abrasion Resistance: Taber CS-17 wheels 1000 gm load on each arm – five thousand (5000) cycles average weight loss for each thousand (1000) cycles no greater than 50 milligrams.
- .3 Divider Strips: 1.25 mm thick zinc selected by [Consultant x thickness of terrazzo topping.
- .4 Accessories: Base caps, base divider strips, separator strips, purpose made and to match divider strips.
- .5 Primer:
 - .1 As recommended by epoxy matrix manufacturer
 - .2 Highly polished, dense concrete: prime using water or solvent thinned, 30% solids with chemical coupling agent additive designed to promote chemical bond to bare concrete.

- .3 Worn, spalled, very porous concrete: prime using 100% solids epoxy primer.
- .4 Oil saturated concrete: chemically remove contamination and mechanically abrade surface. Prime with special oil tolerant, 100% solids modified epoxy primer.
- .5 Damp Sub-Surfaces: Prime for adequate adhesion with waterborne or moisture insensitive epoxy primer. Limit technique to applications which will not result in encapsulation of moisture in concrete or creation of negative side hydrostatic force behind epoxy composition flooring system.
- .6 Primer: Maximum VOC level 100 g/ to SCAQMD Rule 1113.
- .6 Sealing compound as recommended by epoxy matrix manufacturer.
- .7 Non-Slip Material for Inserts: Fine aluminum oxide and mixture in selected colours.
- .8 Sealants:
 - .1 Sealants, Solvents, Cleaners and Other Fluids: water based, water soluble, water clean-up, non-flammable, biodegradable, and low volatile organic compound (VOC) content.
 - .2 Sealants: maximum VOC limit 100 g/L to South Coast Air Quality Management District (SCAQMD) Rule 1168.
 - .3 Water-borne surface coatings:
 - .1 Meet or exceed applicable governmental and/or industrial safety and performance standards.
 - .2 Coatings: Maximum VOC limit to SCAQMD Rule 1113.

2.2 MIXES

- .1 Plastic matrix terrazzo to match TTMAC colour plate selected by the Consultant, using three (3) parts marble chips No.1, one part marble dust No.0, one part epoxy matrix.
- .2 Performance of Epoxy Terrazzo:

Three (3) parts marble chips No. 1
One (1) part marble dust No. 0
One (1) part epoxy resin and hardener

- .1 Impact Strength: Mil D 3134F - drop ball 0.9 kg on 305 x 305 x 6 mm epoxy terrazzo sample, bonded to concrete, 22 J, no visible indentation or chipping.
- .2 Indentation: Test Mil D3134F, Section 4.7.4, 100 x 100 x 6 mm sample no indentation.
- .3 Bond Strength: 2 MPa, 100% concrete failure. Test concrete specimen minimum compressive strength 20 MPa, ACI Manual of Concrete Practice, ACI 503R
- .4 Flammability: Test ASTM D635, self-extinguishing 0.25 maximum
- .5 Thermal Coefficient of Linear Expansion: Test ASTM D696, maximum 25 micrometers/mm/temperature range -24 degrees C to 60 degrees C.

Part 3 Execution

3.1 **MANUFACTURER'S INSTRUCTIONS**

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

3.2 **WORKMANSHIP**

- .1 Do terrazzo work in accordance with CSC Architectural Specification Study on Terrazzo (Thin Gauge Epoxy Matrix Terrazzo), produced in cooperation with Terrazzo, Tile and Marble Association of Canada (TTMAC), except where specified otherwise.
- .2 Moisture content of concrete: maximum 16%.
- .3 Install divider strips straight and level to detailed pattern.
- .4 Install non-slip inserts in as indicated.

3.3 **PREPARATION**

- .1 Chemical:
 - .1 Scrub concrete slab with heavy-duty detergent or cleaners appropriate to emulsify particular contamination present.
 - .2 Rinse with clean water. Repeat procedure as required to remove contamination. Remove rinse water by forcing to appropriate drains or by power vacuum. Perform chemical cleaning in strict accordance with federal, provincial and municipal regulations, which prohibit introduction of certain chemicals and contaminants into sewers, open bodies of water and into ground.
 - .3 Spread acid solution by sprinkle can and scrub into concrete with stiff broom or power scrubber. Use 25% aqueous solution of HCl (muriatic acid) cut 4 or 5 to 1 with water. (Alternatively, to minimize potential damage to metal equipment adjacent to area being prepared, or to steel reinforcement, use 40% phosphoric acid).
 - .4 Rinse with clean water. Repeat procedure as required to remove contamination and acid residue. Remove rinse water by forcing to appropriate drains or by power vacuum. Allow to dry.
- .2 Mechanical Preparation:
 - .1 Shot Blasting: Use steel shot and self-contained abrasive blasting equipment to obtain clean, "white" concrete with uniform stipple finish.
 - .2 Sandblasting, or use of other pneumatically impelled abrasive media:
 - .1 Provide uniformly textured surface.
 - .2 Remove spent abrasive media and loosened concrete particles following blasting with vacuums and brushes.
 - .3 Scarifying:
 - .1 Level deeply scarred subsurface to obtain uniform finish.
 - .2 Supplement removal of penetrated materials, where necessary, by other chemical or mechanical processes.
 - .4 Sanding, or surface abrasion with heavy grit media: corners and edges and full surface.

- .5 Mechanical Keying:
 - .1 Provide crisscrossing saw cuts (6.35 mm deep) to create maximum bond potential.
 - .2 Chisel parallel grooves in subsurface.
- .6 Edge Detailing: Saw cut and chisel leading edges, around drains, joints and cracks to key epoxy overlayment into concrete subsurface.

3.4 **INSTALLATION**

- .1 Floors
 - .1 Mix and install epoxy terrazzo in accordance with manufacturer's instruction, and where possible under direction of manufacturer's representative.
 - .2 Thickness of topping **6 mm** maximum, **3 mm** minimum.
- .2 Built-Up Base: Coved, 6 mm thick topping on cement mix back-up as indicated.
- .3 Finishing: Surface and grout terrazzo when sufficiently hard using No. 24 grit carborundum for initial grinding, and No. 120 grit carborundum for final grinding.
- .4 Sealing: Clean terrazzo and apply sealing compound in accordance with material manufacturer's instructions.

3.5 **SITE QUALITY CONTROL**

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

3.6 **CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Surface preparation and prime painting.
- .2 Wall covering (WCV-1, WCV-2 and WCV-3).

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit WHMIS SDS - Safety Data Sheets in accordance with Section 02 81 00 - Hazardous Materials. WHMIS SDS acceptable to Labour Canada and Health and Welfare Canada for vinyl-coated fabric wall coverings. Indicate VOC content.
 - .2 Submit complete written description, including total fabric weight, name of fabric backing, tensile strength, tear strength and fire rating characteristics.
- .3 Provide samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Due to product lead times, order material immediately upon approval of wall covering from Consultant.
 - .2 Submit duplicate 280 x 215 mm samples of colours and textures of wall coverings.
- .4 Closeout Submittals: Provide maintenance data for vinyl-coated fabric wall covering in accordance with Section 01 78 00 - Closeout Submittals.

1.3 **QUALITY ASSURANCE**

- .1 Field Sample: Before commencing application, prepare wall and apply samples textures of wall covering from current production run of materials selected to show evidence there are no roller marks or other imperfections which may occur during manufacturing process of wall covering to three full wall panels, for Consultant's approval.
- .2 Construct mock-ups in accordance with Section 01 40 00 - Quality Requirements.
 - .1 Apply vinyl-coated wall covering of each finish and decorative effect to 10 m² area of surface to be covered. Approximately three full wall panels.
 - .2 Allow 24 hours for inspection of mock-up by Consultant before proceeding with wall covering work.
 - .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of finished work.

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal: Separate waste materials for reuse and recycling in accordance with Section 01 74 00 - Cleaning and Waste Management.

1.5 **AMBIENT CONDITIONS**

- .1 Temperature: maintain air temperature and structural base temperature at wall covering installation area above 20 degrees C and relative humidity below 40% for 72 hours before, during and 72 hours after installation.

- .2 Ventilation:
 - .1 Ventilate enclosed spaces in accordance with Section 01 51 00 - Temporary Utilities.
 - .2 Provide continuous ventilation during and after coating application.
- .3 Ventilate area of work as directed by Consultant by use of approved portable supply and exhaust fans.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide extra materials of vinyl coated fabric wall covering, adhesives and cleaners in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide full width material of each pattern, texture and colour of vinyl-coated fabric wall covering.
 - .3 Provide sufficient adhesive to install extra material vinyl-coated fabric wall covering provided.
 - .4 Extra materials from same production run/and or dye lot as installed materials.
 - .5 Identify rolls of vinyl-coated fabric wall coverings and containers of adhesives.
 - .6 Deliver to Consultant, upon completion of work of this section.
 - .7 Store where directed by Consultant.

Part 2 Products

2.1 MATERIALS

- .1 Wall Covering (WCV-1, WCV-2 and WCV-3): To CGSB 41-GP-30M, as indicated on finish schedule. Surface burning characteristics in accordance with CAN/ULC-S102
- .2 Manufacturers, products, colours and finishes as indicated on the Drawings.
- .3 Sealer:
 - .1 Type recommended by covering manufacturer.
 - .2 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .4 Sizing: Type recommended by covering manufacturer.
- .5 Adhesive:
 - .1 Wheat powder-based adhesive, as recommended by covering manufacturer.
 - .2 Adhesives: Maximum VOC limit 50 g/L to SCAQMD Rule 1168.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PREPARATION

- .1 Unwrap wall covering when ventilation conditions are accelerated. Allow 24 hours acclimation in installation before application.
- .2 Prepare surfaces according to covering manufacturer's instructions.
- .3 Work penetrating substrate to be completed before installing covering.
- .4 Seal and size surfaces to receive covering.

3.3 INSTALLATION

- .1 Installation sequence:
 - .1 Use rolls in consecutive numerical sequence of manufacture.
 - .2 Place panels consecutively in exact order they are cut from roll; including spaces above or below windows, doors or similar penetrations.
 - .3 Reverse alternate strips except on match patterns.
- .2 Trim additional salvage where required to achieve colour and pattern match at seams.
- .3 Apply adhesive as recommended by manufacturer.
- .4 Hang non-matched patterns by overlapping edges and double cutting through both thicknesses with metal back-up strip to prevent cutting substrate.
- .5 Wrap fabric 150 mm beyond inside and outside corners. No cutting at corners permitted, unless pattern or colour changes.
- .6 No horizontal seams permitted.
- .7 Install covering before installation of plumbing fixtures, electrical equipment, casings, bases and cabinets.
- .8 Remove excess adhesive along finished seams immediately after strips of wall covering is applied. As work progresses ensure clean warm water is used for final rinsing of wall covering and leave clean.
- .9 Leave completed work smooth, clean, without wrinkles, gaps, overlaps or air pockets.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .2 Clean surfaces to covering manufacturer's written instructions.

3.5 PROTECTION

- .1 Protect finished surfaces and exterior corners from damage until **final inspection**.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Wall protection systems, including rigid sheet wall covering panels.

1.2 **SUBMITTALS**

- .1 General: Submit the following in accordance with conditions of the Contract and Division 01 Specification Sections.
- .2 Product data for each wall surface protection system component and installation accessory required, including installation methods for each type of substrate. Provide written data on each required component including physical characteristics, such as durability, resistance to fading and flame resistance.
- .3 Shop Drawings showing locations, extent and installation details of wall covering panels and layout of panels and trim accessories.
- .4 Samples for Initial Selection: For initial selection of color, pattern and surface texture, provide the manufacturer's standard color chips consisting of actual sections of wall panel material required showing the full range of materials, colors and textures available.
- .5 Product test reports from an independent testing laboratory showing compliance of wall surface protection system components with requirements indicated based on tests performed by the laboratory within the past five (5) years.
- .6 Maintenance data for wall surface protection system components for inclusion in the Operating and Maintenance Manuals.

1.3 **QUALITY ASSURANCE**

- .1 Installer Qualifications: Engage an experienced installer who has previously installed wall surface protection systems similar in material, design and extent to the systems indicated for this Project.
- .2 Manufacturer Qualifications: Firm experienced in manufacturing wall surface protection system components that are similar to those required for this Project and that have a record of successful in-service performance.
- .3 Fire Performance Characteristics:
 - .1 Provide wall surface protection system components that are identical to those tested in accordance with ASTM E 84 for the fire performance characteristics indicated herein. Identify wall surface protection system components with appropriate markings from the testing and inspection organization.
 - .2 Flame Spread: 25 or less.
 - .3 Smoke Developed: 450 or less.
- .4 Single Source Responsibility: Obtain each color, grade, finish and type of wall surface protection system component from a single source with resources to provided products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.4 **DELIVERY, STORAGE and HANDLING**

- .1 Deliver materials to Project site in original factory wrappings and containers, clearly labeled with identification of manufacturer, brand name, quality or grade and fire hazard classification.

- .2 Store wall surface protection materials in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures and humidity.
- .1 Maintain room temperature within the storage area at not less than 70 deg F (21 deg C) during the period materials are stored. Keep sheet material out of direct sunlight to avoid surface distortion.

1.5 MAINTENANCE

- .1 Maintenance Instructions: Provide the manufacturer's instructions for maintenance of installed work. Include recommended methods and frequency for maintaining optimum condition under anticipated traffic and use conditions. Include precautions against cleaning materials and methods that may be detrimental to finishes and performance.
- .2 Replacement Materials: After completion of work, deliver not less than 2% of each type, color and pattern of wall surface protection materials and components. Include accessory components as required. Replacement materials shall be from the same production run as materials installed. Package replacement materials with protective covering, identified with appropriate labels.

Part 2 Products

2.1 MANUFACTURERS AND PRODUCTS

- .1 Subject to compliance with requirements, provide products equivalent to "Glasbord-FSI" by Kemlite Company or approved alternate.
- .2 Description:
 - .1 Prefabricated fiberglass reinforced plastic panels designed to be laminated to wall construction, complete with manufacturer's proprietary moldings and trim, to produce easy-to-clean, sanitary wall finish.
 - .2 Panel Size: 4'-0" (1.2 m) x 8'-0", 9'-0" or 10'-0" (2.4, 2.7 or 3 m) as required for floor to ceiling fit.
 - .3 Panel Thickness: .075 (1.9 mm).
 - .4 Surface Finish: Smooth.
 - .5 Color: White.
 - .6 Certifications: USDA/FSIS.
 - .7 Surface Burning Characteristics: Class A (ASTM E-84).
- .3 Adhesives: Panel manufacturer recommended adhesives.
- .4 Accessories: Panel butt-joint and perimeter plastic moldings and trim as provided by panel manufacturer.
- .5 Joint Sealants: Refer to Section 07 92 00 - Joint Sealants for sealant materials to be used at panel joints.

2.2 FABRICATION

- .1 General: Fabricate wall covering panels to comply with requirements indicated for design, dimensions, details, finish and sizes, including panel thickness.
- .2 Provide adhesives, moldings and trim components for a complete installation.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Examine areas and conditions in which wall surface protection systems will be installed.
- .2 Complete finishing operations, including painting, before beginning installation of wall surface protection system materials.
- .3 Do not proceed with installations until unsatisfactory conditions have been corrected.

3.2 **PREPARATION**

- .1 General: Prior to installation, clean substrate to remove dust, debris and loose particles.

3.3 **INSTALLATION**

- .1 General:
 - .1 Install wall surface protection units plumb, level and true to line without distortions with full-spread adhesive method.
 - .2 Do not use materials with chips, cracks, voids, stains or other defects that might be visible in the finished work.
- .2 Install wall panel accessories in strict accordance with the manufacturer's instructions. Seal joint and perimeter moldings and trim with silicone sealant prior to installation of panels.

3.4 **CLEANING**

- .1 General: Immediately upon completion of installation, clean wall panels using recommended cleaning agents in accordance with the manufacturer's recommendations.
- .2 Remove excess adhesive using methods and materials recommended by manufacturer.
- .3 Remove surplus materials, rubbish and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 sound attenuation blankets, acoustical joint sealants, acoustical putty pads and accessories.

1.2 **DEFINITIONS**

- .1 Acoustic Rated Assemblies: Acoustic rated assemblies include, but may not be limited to partitions, walls, floors, floor-ceiling assemblies and roof-ceiling assemblies.

1.3 **ACTION SUBMITTALS**

- .1 Product Data: For each product.
- .2 Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- .3 Samples for Verification: For each kind and color of acoustical joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- .4 Acoustical Joint Sealant Schedule: Include the following information:
 - .1 Joint sealant application, joint location and designation.
 - .2 Joint sealant manufacturer and product name.
 - .3 Joint sealant formulation.
 - .4 Joint sealant color.

1.4 **INFORMATIONAL SUBMITTALS**

- .1 Product Test Reports: For each Product, for tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency.
- .2 Sample Warranties: For special warranties.

1.5 **WARRANTY**

- .1 Special installer's Warranty:
 - .1 Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified herein within specified warranty period.
 - .2 Warranty Period: Two (2) years from date of Substantial Completion.
- .2 Special Manufacturer's Warranty:
 - .1 Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified herein within specified warranty period.
 - .2 Warranty Period: Five (5) years from date of Substantial Completion.

Part 2 Products

2.1 **PERFORMANCE REQUIREMENTS**

- .1 Provide acoustical Products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.

2.2 **SOUND ATTENUATION BLANKETS**

- .1 Sound Attenuation Blankets: ASTM C665, Type I; unfaced mineral fiber batts; minimum fire hazard classification rating of 0/0 per ASTM E84; thickness as indicated on Drawings to meet acoustical requirements; widths to friction-fit between studs, where indicated for installation in stud walls; formaldehyde free.
- .2 Sound Attenuation Blankets: ASTM C665, Type I; unfaced glass fiber batts, blankets or rolls; minimum fire hazard classification rating of 25/50 per ASTM E84; thickness as indicated on Drawings to meet acoustical requirements; widths to friction-fit between studs, where indicated for installation in stud walls; formaldehyde free.

2.3 **ACOUSTICAL JOINT SEALANTS**

- .1 Acoustical Sealant for Exposed and Concealed Joints:
 - .1 Manufacturer's standard non-sag, paintable, non-staining latex acoustical sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - .2 Subject to compliance with requirements, provide the following Products:
 - .1 Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
 - .2 Franklin International; Titebond GREENchoice Professional Acoustical Smoke & Sound Sealant.
 - .3 Grabber Construction Products; Acoustical Sealant GSC.
 - .4 Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
 - .5 Pecora Corporation; AC-20 FTR or AIS-919.
 - .6 Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
 - .7 United States Gypsum Company; SHEETROCK Acoustical Sealant.
 - .3 Colors of Exposed Acoustical Joint Sealants: As selected by the Consultant from manufacturer's full range of colors.
 - .4 Sealant shall have a volatile organic content (VOC) of 250 g/L or less.

2.4 **ACOUSTICAL PUTTY PADS**

- .1 Acoustical seal pads for use on electrical boxes, thermostat boxes, audiovisual control boxes, door operating hardware boxes and similar items penetrating acoustical rated partitions.
- .2 Subject to compliance with the requirements, provide one (1) of the following Products:
 - .1 Firetemp Putty Pads by Johns Manville.
 - .2 CP 617 Firestop Putty Pad by Hilti.

.3 Fire Barrier Moldable Putty by 3M.

.3 Characteristics:

- .1 Composition: Polymer/Butyl rubber blend, self-adhering, providing non-hardening, flexible sheet for sealing non-fire rated wall and ceiling penetrations.
- .2 Density: Minimum 10-12 lbs/gal (1.2-1.45 g/cm³).
- .3 Minimum Thickness: 1/10-inch (2.54 mm).
- .4 Service Temperature Range: Minus 20 deg F to 180 deg F.
- .5 VOC Emissions: SCAQMD Compliant.

2.5 **ACOUSTICAL PATHWAYS**

- .1 Control voltage, communications and electronic safety and security cable penetrations in acoustical rated assemblies. Provide acoustical pathways with the ability for Owner to add or remove cables without the need for replacing fill materials.
 - .1 Basis-of-Design Product:
 - .1 Subject to compliance with the requirements, provide the following acoustic rated assembly or approved alternate product.
 - .2 EZ Path Series 33NEZ Smoke and Acoustical Pathway by Specified Technologies, Inc.
 - .2 Provide collars and plates required for mounting single and multiple devices adjacent to each other.
 - .3 Accessories: Provide accessories required for applications indicated on Drawings:
 - .1 Extension module increasing effective length.
 - .2 Radius control module providing minimum bend radius for twisted pair cables.
 - .3 Multi-gang wall bracket to allow one to five pathways in finished wall to be supported from stud.
 - .4 Modular floor grid system allowing banks of pathways in floor.
 - .5 Caps for unoccupied wall bracket gangs to allow future capacity.

2.6 **MISCELLANEOUS MATERIALS**

- .1 Primer: Material recommended by acoustical joint sealant manufacturer where required for adhesion of sealant to joint substrates.
- .2 Cleaners for Non-Porous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant 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, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.
- .4 Acoustical Gasket:
 - .1 Self-adhering neoprene isolation gaskets, for use between steel studs and structure in acoustical rated partitions. Closed cell foam, ½-inch thick by width of steel stud.

- .2 Products: Subject to compliance with the requirements, provide the following or approved alternate Product: Neoprene Isolation Gasket PSA by SoundAway Corporation.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Section 01 71 00 - Examination and Preparation: Verify existing conditions before starting work.
- .2 Prior to starting Work, carefully inspect installed work of other trades and verify that such work is complete to the point where Work of this Section may properly commence.
- .3 Examine joints indicated to receive acoustical joint sealants, with installer present, for compliance with requirements for joint configuration, installation tolerances and other conditions affecting performance of the Work.
- .4 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **PREPARATION**

- .1 Verify that adjacent materials are secure, properly spaced, dry and ready to receive installation.
- .2 Verify that mechanical and electrical services within spaces to be insulated have been installed and tested.
- .3 Furnish acoustical insulation to hollow metal installer for installation in hollow metal frames in acoustical partitions.
- .4 Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint sealant manufacturer's written instructions.
- .5 Joint Priming: Prime joint substrates where recommended by acoustical joint sealant manufacturer. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint sealant bond, do not allow spillage or migration onto adjoining surfaces.
- .6 Masking Tape: Use masking tape where required to prevent contact of sealant or primer 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.
- .7 Acoustical Pathways: Coordinate calculations of allowable fill ratio with control voltage, communications and electronic safety and security installers to ensure size of sleeves, openings, core-drilled holes or cut openings can accommodate cable load according to specified conduit fill

3.3 **INSTALLATION OF SOUND ATTENUATION BLANKETS**

- .1 Install insulation in stud cavities in accordance with manufacturer's instructions and as indicated. Coordinate with other trades as necessary to complete acoustical barriers at wall penetrations.
- .2 Install sound attenuation blankets before installing wall panels unless blankets are readily installed after panels have been installed on one side.
- .3 Install insulation without gaps or voids.
- .4 Trim insulation neatly to fit spaces. Use insulation materials free of damage.

- .5 For installation at partition head tracks and acoustically insulated door frames: Install continuous strips, full width of partition or frame.

3.4 **INSTALLATION OF ACOUSTICAL JOINT SEALANTS**

- .1 Comply with acoustical joint sealant manufacturer's written installation instructions unless more stringent requirements apply.
- .2 Non-Acoustical Rated Partitions: Install acoustical joint sealants at both faces of partition at perimeters.
- .3 Acoustical Rated Partitions and Assemblies: Seal construction at perimeters, behind control joints and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters and through penetrations. Comply with ASTM C 919, ASTM C 1193 and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.
- .4 Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.5 **INSTALLATION OF ACOUSTICAL PUTTY PADS**

- .1 Install acoustical putty pads on all electrical boxes, thermostat boxes, audiovisual control boxes, door operating hardware boxes and similar items penetrating acoustical rated partitions.
- .2 Overlap acoustical putty pads as required to uniformly cover all sides of electrical boxes.
- .3 Press acoustical putty pads tightly around conduits and box and wrap around front of box, to be depressed by gypsum board. Fill remaining gaps between electrical box and gypsum board with acoustic sealant to provide an airtight seal.

3.6 **INSTALLATION OF ACOUSTICAL PATHWAYS**

- .1 Install acoustical pathways at control voltage, communications and electronic safety and security cable penetrations in acoustical rated assemblies:
 - .1 Comply with manufacturer's written installation instructions unless more stringent requirements apply.
 - .2 Where specified mechanical device cannot be used in openings in floors and walls, provide products that allow re-entry and do not cure or dry.
 - .3 Where empty sleeves are installed for future cables or as abandoned cables are harvested, seal both sides of empty sleeves with acoustically rated plug.

3.7 **CLEANING**

- .1 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 acoustical joint sealants and of products in which joints occur.

3.8 PROTECTION

- .1 Protect acoustical 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 Completion. If, despite such protection, damage or deterioration occurs, cut out, remove and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Surface preparation and application of high-performance coating systems. on the following substrates:

- .1 Interior substrates including, but not limited to:
- .1 Concrete, vertical and horizontal surfaces.
 - .2 Steel.
 - .3 Galvanized metal.
 - .4 Aluminum (not anodized or otherwise coated).
 - .5 Wood.
 - .6 Gypsum wallboard (GWB).

1.2 **ADMINISTRATIVE REQUIREMENTS**

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

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
- .1 Provide manufacturer's instructions, printed product literature and data sheets for paint and paint products and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two (2) copies of Workplace Hazardous Materials Information System (WHMIS) safety data sheets (SDS) in accordance with Section 01 35 23 - Health and Safety.
 - .3 Confirm products to be used are in Master Painters Institute's (MPI) approved product list.
- .3 Upon completion, provide records of products used. List products in relation to finish system and include the following:
- .1 Product name, type and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.
 - .4 MPI Environmentally Friendly classification system rating.
 - .5 Manufacturer's SDS.

- .4 Samples:
 - .1 Submit full range colour sample chips to indicate where colour availability is restricted.
 - .2 Submit duplicate 200 x 300 mm sample panels of each paint with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:
 - .1 3 mm plate steel for finishes over metal surfaces.
 - .2 13 mm birch plywood for finishes over wood surfaces.
 - .3 50 mm concrete block for finishes over concrete surfaces.
 - .4 13 mm GWB for finishes over GWB and other smooth surfaces.
 - .3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.
- .5 Test reports: Provide certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .1 Lead, cadmium and chromium: presence of and amounts.
 - .2 Mercury: presence of and amounts.
 - .3 Organochlorines and PCBs: presence of and amounts.
- .6 Certificates: Provide certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties. MPI Gateway #.
- .7 Manufacturer's Instructions: Provide manufacturer's installation and application instructions.

1.4 **CLOSEOUT SUBMITTALS**

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

1.5 **MAINTENANCE MATERIAL SUBMITTALS**

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

1.6 **QUALITY ASSURANCE**

.1 Qualifications:

- .1 Contractor: to have a minimum of five (5) years proven satisfactory experience. When requested, provide list of last three (3) comparable jobs including, job name and location, specifying authority and project manager.
- .2 Qualified journeypersons as defined by local jurisdiction to be engaged in painting work.
- .3 Apprentices may be employed provided they work under direct supervision of qualified journeyperson in accordance with trade regulations.
- .4 Conform to latest MPI requirements for exterior painting work including preparation and priming.
- .5 Materials in accordance with MPI Painting Specification Manual "Approved Product" listing and from a single manufacturer for each system used.
- .6 Retain purchase orders, invoices and documents to prove conformance with noted MPI requirements when requested by Consultant.
- .7 Standard of Acceptance:
 - .1 Walls: No defects visible from 1000 mm at 90° to surface.
 - .2 Soffits: No defects visible from floor at 45° to surface when viewed using final lighting source.
 - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

.2 Mock-Ups:

- .1 When requested by Consultant or Paint Inspection Agency, prepare and paint designated surface, area, room or item to requirements specified herein, with specified paint or coating showing selected colours, number of coats, gloss/sheen, textures and quality of work to MPI Painting Specification Manual standards for review and approval.
- .2 Construct mock-ups in accordance with Section 01 43 00 - Quality Assurance.
 - .1 Provide mock-up, size as indicated by the Consultant. Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen, textures.
 - .2 Locate where directed.
 - .3 Allow twenty-four (24) hours for inspection of mock-up before proceeding with Work.
 - .4 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

1.7 **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:
 - .1 Deliver materials to the Project site in original factory packaging, labelled with manufacturer's name and address.
 - .2 Labels to Indicate:
 - .1 Type of paint or coating.
 - .2 Compliance with applicable standard.
 - .3 Colour number in accordance with established colour schedule.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Observe manufacturer's recommendations for storage and handling.
 - .3 Store materials and supplies away from heat generating devices.
 - .4 Store materials and equipment in well-ventilated area with temperature range 7°C to 30°C.
 - .5 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Consultant. After completion of operations, return areas to clean condition to approval of Consultant.
 - .6 Remove paint materials from storage only in quantities required for same day use.
 - .7 Comply with requirements of WHMIS regarding use, handling storage and disposal of hazardous materials.
 - .8 Fire Safety Requirements:
 - .1 Provide one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada (NFC).
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 00 - Cleaning and Waste Management.

1.8 **SITE CONDITIONS**

- .1 Ambient Conditions:
 - .1 Heating, Ventilation and Lighting:
 - .1 Ventilate enclosed spaces.
 - .2 Provide heating facilities to maintain ambient air and substrate temperatures above 10°C for twenty-four (24) hours before, during and after paint application until paint has cured sufficiently.
 - .3 Provide continuous ventilation for seven (7) days after completion of application of paint.

- .4 Coordinate use of existing ventilation system with Consultant and ensure its operation during and after application of paint as required.
- .5 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
- .6 Provide minimum lighting level of 323 Lux on surfaces to be painted.
- .7 Temperature, Humidity and Substrate Moisture Content Levels: As required for each substrate application.
- .8 Surface and Environmental Conditions: As required for each substrate application.
- .9 Additional interior application requirements: As required for each substrate application.

Part 2 Products

2.1 **PERFORMANCE REQUIREMENTS**

.1 Environmental Performance Requirements:

- .1 Provide paint products meeting MPI "Environmentally Friendly" E1 ratings based on VOC (Environmental Protection Agency [EPA] Method 24) content levels.
- .2 Green Performance in accordance with MPI Standard GPS-1.

2.2 **MATERIALS**

- .1 Only Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this Project.
- .2 Provide paint materials for paint systems from single manufacturer.
- .3 Only qualified products with "Environmentally Friendly" rating are acceptable for use on this Project.
- .4 Conform to latest MPI requirements for interior painting work including preparation and priming.
- .5 Provide paint products meeting MPI "Environmentally Friendly" ratings based on VOC (EPA Method 24) content levels.
- .6 Use MPI listed materials having minimum rating where indoor air quality (odor) requirements exist.
- .7 Paints, coatings, adhesives, solvents, cleaners, lubricants and other fluids to be:
 - .1 Water-based.
 - .2 Be non-flammable and biodegradable.
 - .3 Be manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
 - .4 Be manufactured without compounds which contribute to smog in the lower atmosphere.
 - .5 Do not contain methylene chloride, chlorinated hydrocarbons and/or toxic metal pigments.

- .8 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:
 - .1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
 - .2 Total Suspended Solids (TSS) in undiluted production plant effluent more than 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.
- .9 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes to meet minimum "Environmentally Friendly" rating.
- .10 Recycled water-borne surface coatings to contain 50 % post-consumer material by volume.
- .11 Recycled water-borne surface coatings must not contain:
 - .1 Lead in excess of 600 ppm weight/weight total solids.
 - .2 Mercury in excess of 50 ppm weight/weight total product.
 - .3 Cadmium in excess of 1 ppm weight/weight total product.
 - .4 Hexavalent chromium in excess of 3 ppm weight/weight total product.
 - .5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1 ppm weight/weight total Product.

2.3 COLOURS

- .1 Consultant will provide Colour Schedule after Contract award.
- .2 Colour schedule will be based upon selection of five (5) base colours and three (3) accent colours. No more than eight (8) colours will be selected for entire Project and no more than three (3) colours will be selected in each area.
- .3 Selection of colours will be from manufacturers full range of colours.
- .4 Where specific products are available in restricted range of colours, selection based on limited range.
- .5 Second coat in three (3) coat system to be tinted slightly lighter colour than topcoat to show visible difference between coats, if requested by Consultant.
- .6 For deep and ultra deep colours, four (4) coats may be required.

2.4 MIXING AND TINTING

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

2.5 GLOSS/SHEEN RATINGS

- .1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:
- .2 Gloss level ratings of painted surfaces as noted on Finish Schedule.

2.6 SOURCE QUALITY CONTROL

- .1 Perform following tests on each batch of consolidated post-consumer material before surface coating is reformulated and canned. Testing by laboratory or facility which has been accredited by Standards Council of Canada.
 - .1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.
 - .2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.
 - .3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: Comply with manufacturer's written recommendations or specifications, including Product technical bulletins, handling, storage and installation instructions and data sheet.

3.2 GENERAL

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

3.3 EXAMINATION

- .1 Verification of Conditions:
 - .1 Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable to be painted in accordance with manufacturer's written instructions.
 - .2 Visually inspect substrate in presence of Consultant.
 - .3 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.
- .2 Interior Repainting Work: Inspected by MPI accredited paint inspection agency (inspector) acceptable to specifying authority and local painting contractor's association. Painting contractor to notify paint inspection agency minimum of one (1) week prior to commencement of work and provide copy of project repainting specification and Finish Schedule.

- .3 Interior Surfaces Requiring Repainting: Inspected by both painting contractor and paint inspection agency who will notify Consultant in writing of defects or problems, prior to commencing repainting work or after surface preparation if unseen substrate damage is discovered.
- .4 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .5 Maximum moisture content as follows:
 - .1 Stucco, Plaster and GWB: 12 %.
 - .2 Concrete: 12 %.
 - .3 Clay and Concrete Block/Brick: 12 %.
 - .4 Hard Wood: 15 %.
 - .5 Soft Wood: 17%.

3.4 **PREPARATION**

- .1 Protection (not applicable to new painting work):
 - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Consultant.
 - .2 Protect items that are permanently attached such as fire labels on doors and frames.
 - .3 Protect factory finished products and equipment.
 - .4 Protect passing pedestrians, building occupants and public in and about the building.
- .2 Surface Preparation (not applicable to new painting work):
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Consultant.
- .3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual regarding specific requirements and as follows:
 - .1 Remove dust, dirt and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly.

- .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
- .6 Use trigger operated spray nozzles for water hoses.
- .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.
- .4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint or pretreatment as soon as possible after cleaning and before deterioration occurs.
- .5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
 - .1 Apply sealer to MPI #36 over knots, pitch, sap and resinous areas.
 - .2 Apply wood filler to nail holes and cracks.
 - .3 Tint filler to match stains for stained woodwork.
- .6 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- .7 Carried out during shop priming: clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes, blowing with clean dry compressed air or vacuum cleaning.
- .8 Touch-up of shop primers with primer as specified.
- .9 Do not apply paint until prepared surfaces have been accepted by Consultant.

3.5 **EXISTING CONDITIONS**

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

3.6 **APPLICATION**

- .1 Method of application to be as approved by Consultant, brush, roller, air sprayer or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - .2 Work paint into cracks, crevices and corners.

- .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
- .4 Brush and/or roll out runs and sags and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
- .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.
 - .4 Brush out immediately runs and sags.
 - .5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.
- .5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time as recommended by manufacturer.
- .7 Sand and dust between coats to remove visible defects.
- .8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .9 Finish inside of cupboards and cabinets as specified for outside surfaces.
- .10 Finish closets and alcoves as specified for adjoining rooms.
- .11 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.
- .12 Wood, GWB, plaster, stucco, concrete, concrete masonry units and brick; if sprayed, must be back rolled.

3.7 **MECHANICAL/ELECTRICAL EQUIPMENT**

- .1 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.
- .2 Boiler Room, Mechanical and Electrical Rooms: Paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.
- .3 Other Unfinished Areas: Leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .4 Do not paint over nameplates.
- .5 Keep sprinkler heads free of paint.

- .6 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- .7 Paint fire protection piping red.
- .8 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- .9 Paint natural gas piping yellow.
- .10 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required and paint conduits, mounting accessories and other unfinished items.
- .11 Do not paint interior transformers and substation equipment.

3.8 **SITE TOLERANCES**

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

3.9 **SITE QUALITY CONTROL**

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

3.10 CLEANING

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

3.11 RESTORATION

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

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Visual display enclosure.

1.2 **ACTION SUBMITTALS**

- .1 Product Data: Visual display enclosure.
- .2 Product Data Submittals:
 - .1 For each product.
 - .2 Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display enclosures.
 - .3 Include documentation indicating that product contains no urea formaldehyde in compliance with California Air Resources Board (CARB) regulations.
- .3 Shop Drawings:
 - .1 For visual display enclosure(s).
 - .2 Include plans, elevations, sections, details, and attachment to other work.

1.3 **INFORMATIONAL SUBMITTALS**

- .1 Qualification Data: For Installer.
- .2 Sample Warranties: For manufacturer's special warranties.

1.4 **QUALITY ASSURANCE**

- .1 Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver factory-fabricated visual display enclosures completely assembled in one (1) piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one (1) piece, provide two (2) or more pieces with joints in locations indicated on approved Shop Drawings.

1.6 **FIELD CONDITIONS**

- .1 Environmental Limitations: Do not deliver or install visual display enclosures until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

Part 2 Products

2.1 **LIGATURE RESISTANT VISUAL DISPLAY ENCLOSURES**

- .1 Basis of Design Product: Subject to compliance with requirements, provide Model "TE540 – TV Enclosure" as manufactured by Behavioural Safety Products or approved alternate.

- .2 Description:
 - .1 Corners: Molded nylon black corners with three (3) holes for ¼" – 20 x ¾" screws with a secured polycarbonate cap to cover screws. The corners are rounded with no sharp edges. Each corner has a polycarbonate cap to cover the corner screws with a recessed pinhead Torx tamper resistant screw for fastening to the corners.
 - .2 Sloped Top: A 22° sloped top prevents ligature or looping.
 - .3 Mounting Feet to Wall: Six (6) aluminum angle black anodized.
 - .4 Sides/Top/Bottom Material: ¼" thick black satin ABS.
 - .5 Front: ¼" thick optical grade polycarbonate.
 - .6 Fans: Two (2) USB 5V powered fans with slotted holes located in the sloped top. Size varies based on the depth of the unit. Provide adequate cooling for TV.
 - .7 Power: 120v–5v wall transformer rated at Input 120V.15A; Output 5vDC .5A.
 - .8 Fuse: 5 x 20 mm .5A 250V.
 - .9 Ventilation: Six (6) patterns of 3/32" ventilation holes (two [2] in sloped top, two [2] in top of enclosure, and two [2] in bottom of enclosure).
- .3 Size: As indicated on Drawings.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- .2 Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.
- .3 Examine walls and partitions for proper preparation and backing for visual display enclosure.
- .4 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- .1 Comply with manufacturer's written instructions for surface preparation.
- .2 Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- .3 Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.

3.3 INSTALLATION

- .1 General: Install visual display enclosures in locations and at mounting heights indicated on Drawings.
- .2 Keep perimeter lines straight, level, and plumb.
- .3 Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

- .4 Visual Display Enclosure Mounting Heights: As indicated on Drawings.

3.4 **CLEANING AND PROTECTION**

- .1 Clean visual display units in accordance with manufacturer's written instructions. Attach one (1) removable cleaning instructions label to visual display unit in each room.
- .2 Touch up factory-applied finishes to restore damaged or soiled areas.
- .3 Cover and protect visual display units after installation and cleaning.

3.5 **DEMONSTRATION**

- .1 Train Owner's maintenance personnel to adjust, operate, and maintain motorized, sliding visual display units.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Wall protection.
- .2 Related accessories.

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for wall and corner guards and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 23 - Health and Safety. Indicate volatile organic compounds (VOC's) for material as follows:
 - .1 Caulking materials during application and curing.
 - .2 Adhesives.
- .3 Installation Drawings: Indicate on drawings large scale details, materials, finishes, dimensions, anchorage and assembly.
- .4 Samples: Submit duplicate 300 mm long samples of profiles and colours for wall guards.

1.3 **QUALITY ASSURANCE**

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

1.4 **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 off ground, indoors and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wall guards from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 00 - Cleaning and Waste Management and Waste Management.

Part 2 Products

2.1 **MATERIALS**

- .1 High strength PVC compound, selected by the Consultant from manufacturer's standard range.
- .2 Wall Protection (WP-3, WP-4 and WP-5): Manufacturers, products, colours and finishes as indicated on the Drawings.

2.2 **ACCESSORIES**

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

2.3 **FINISHES**

- .1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
 - .1 As fabricated or mill finish.
 - .2 Integral colour anodic finish to match Consultant's approved sample.
- .2 Appearance and properties of anodized finishes designated by the Aluminum Association as Architectural Class 1, Architectural Class 2, and Protective and Decorative.

Part 3 Execution

3.1 **EXAMINATION**

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

3.2 **MANUFACTURER'S INSTRUCTIONS**

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

3.3 **INSTALLATION**

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

3.4 CLEANING

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management and Waste Management.
 - .2 Leave Work area clean at end of each day.
- .2 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .3 Clean surfaces after installation using manufacturer's written recommended cleaning procedures.
- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .5 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .6 Waste Management: Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

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

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Washroom accessories.
- .2 Custodial accessories.

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Provide manufacturer's printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Canada.
 - .2 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, building-in details of anchors for grab bars.
- .4 Samples:
 - .1 Submit samples for items specified herein.
 - .2 Samples will be returned for inclusion into work.
- .5 Sustainable Standards Certification: Low-Emitting Materials: Submit listing of laminate adhesives used in building, verifying that they contain no urea-formaldehyde.

1.3 **CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for toilet and bath accessories for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 **MAINTENANCE MATERIAL SUBMITTALS**

- .1 Tools:
 - .1 Provide special tools required for assembly, disassembly or removal for toilet and bath accessories in accordance with requirements specified in Section 01 78 00 - Closeout Submittals.
 - .2 Deliver special tools to departmental representative.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: Deliver materials to Project site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect toilet and bathroom accessories from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.
 - .4 Packaging Waste Management: Remove for reuse and return to manufacturer, the following, including but not limited to return pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.
- Part 2 Products
- 2.1 **MATERIALS**
- .1 Sheet steel to ASTM A653/A653M with ZF001 designation zinc coating.
 - .2 Stainless steel sheet metal to ASTM A167, Type 304, with finish as indicated on the Drawings.
 - .3 Sustainability Characteristics: Laminate adhesives to be urea formaldehyde free.
 - .4 Stainless Steel Tubing: Type 304, commercial grade, seamless welded, 1.2 mm wall thickness.
 - .5 Fasteners: Concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.
- 2.2 **COMPONENTS**
- .1 Toilet Tissue Dispenser:
 - .1 Recessed Toilet Paper Holder with square bezel shall have an interior measuring 127 mm in diameter and 114 mm in depth to accommodate one (1) standard toilet paper roll.
 - .2 Fabricated of alloy 18-8 stainless steel, type 304, 14 gauge.
 - .3 Beveled trim shall have No 4 satin finish and four (4) mounting holes.
 - .4 Interior shall have glass blasted satin matte finish.
 - .5 Mounting hardware (supplied) shall consist of four (4) #12-24 pin-Torx round head machine screws.
 - .6 Model 110-13 as manufactured by American Specialties Inc.
 - .2 Paper Towel Dispenser: Provided by the Owner installed by this Contractor.
 - .3 Soap Dispenser: Provided by the Owner installed by this Contractor.
 - .4 Grab Bars:
 - .1 Ligature resistant grab bar c/w tamper resistant fasteners.
 - .2 Mounting, locations and orientation as indicated on the Drawings or back-to-back on 90-degree corner.
 - .3 Mounted from front of wall.
 - .4 Length(s) as indicated on the Drawings.
 - .5 Secure unit with provided tamper resistant stainless-steel screws.
 - .6 Aluminum construction with white powder coat.
 - .7 Pick free joint caulk recommended.
 - .8 The Accessibility for Ontarians with Disabilities Act 2005 (AODA) compliant when installed per published AODA requirements.

- .9 Model GB730 as manufactured by Behavioral Safety Products.
- .5 Anti-Ligature Coat Hook:
 - .1 High silicone content that is inserted into a stainless-steel surround.
 - .2 Model KG180 as manufactured by the Kingsway Group Inc.
- .6 Ligature Resistant Framed Mirror:
 - .1 Polished stainless steel mirror face.
 - .2 Size: 18" x 24".
 - .3 White powder coat exterior.
 - .4 Unit secured c/w tamper resistant stainless-steel screws.
- .7 Stainless Steel Mop and Broom Holder:
 - .1 Mounting Base: 18-8, type-304, 22-ga (0.8 mm) stainless steel with satin finish.
 - .2 Mop and Broom Holders: Spring-loaded rubber cam holders with anti-slip coating. Powder coated steel retainers.
 - .3 Mop and broom holder shall be Type-304 stainless steel with satin finish. Unit length as indicated on the Drawings, with number of spring-loaded rubber cam holders required for length of holder specified.
 - .4 Model B-223 as manufactured by Bobrick Washroom Equipment Inc.
- .8 Recessed Shelf:
 - .1 Minimum inside dimensions of 16" wide x 5" high x 4" deep (406 wide x 127 high x 102 mm deep), formed from 0.062-inch- (1.57 mm) thick, stainless-steel sheet; with 1 ½" (38.1 mm) wide, flanged front edge.
 - .2 Mounting: Front mounting with security fasteners and wall anchors.
 - .3 Finish: Polished stainless steel.
 - .4 Model WH1820FA-SS as manufactured by Whitehall Manufacturing.

2.3 **FABRICATION**

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

2.4 FINISHES

- .1 Chrome and nickel plating: to ASTM B456, polished finish.
- .2 Baked Enamel: Condition metal by applying one (1) coat of metal conditioner to CGSB 31-GP-107Ma, apply one (1) coat Type 2 primer to CAN/CGSB-1.81 and bake, apply two (2) coats Type 2 enamel to CAN/CGSB-1.88 and bake to hard, durable finish. Sand between final coats.
- .3 Colour(s) selected from standard range by Consultant.
- .4 Manufacturers or brand names on face of units not acceptable.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: Verify that conditions of substrates and surfaces to receive toilet and bathroom accessories previously installed under other Sections or Contracts are acceptable for Product installation in accordance with manufacturer's instructions prior to toilet and bathroom accessories installation.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval from departmental representative and Consultant.

3.2 INSTALLATION

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

3.3 ADJUSTING

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

3.4 CLEANING

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.

- .2 Leave Work area clean at end of each Working Day.
- .2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .3 Waste Management:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .2 Remove recycling containers and bins from Project site and dispose of materials at appropriate facility.
- 3.5 **PROTECTION**
 - .1 Protect installed products and components from damage during construction.
 - .2 Repair damage to adjacent materials caused by toilet and bathroom accessories installation.
- 3.6 **SCHEDULE**
 - .1 Locate accessories where indicated. Exact locations determined by documents as per the Consultants.
 - .2 Quantities and locations each accessory specified, as indicated on the Drawings.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Fire protection cabinets.

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's printed product literature and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide Shop Drawings.
- .4 Quality Assurance Submittals:
 - .1 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.
 - .2 Manufacturer's Field Reports: submit manufacturer's written reports within three (3) days of review, verifying compliance of Work, as described herein.
- .5 Closeout Submittals: Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 **DELIVERY, STORAGE AND HANDLING**

- .1 Packing, Shipping, Handling and Unloading: Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal: Separate waste materials for reuse and recycling in accordance with Section 01 74 00 - Cleaning and Waste Management.

Part 2 Products

2.1 **CABINETS**

- .1 Mounting type as indicated on the Drawings, constructed of 1/16" (1.6 mm) thick steel, 180° opening door of 2.5 mm thick steel with latching device.
- .2 Cabinet to maintain fire resistive rating of construction in which they occur.
- .3 Cabinet door with metal panel.
- .4 Finish:
 - .1 Tub: Prime coated.
 - .2 Door and Frame: Finish and colour as selected by the Consultant from the manufacturer's standard ranges.

2.2 **FABRICATION**

- .1 Fire-Protection Cabinets:
 - .1 Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - .2 Weld joints and grind smooth.
 - .3 Miter corners and grind smooth.
 - .4 Provide factory-drilled mounting holes.

- .5 Prepare doors and frames to receive locks.
- .6 Install door locks at factory.
- .2 Cabinet Doors:
 - .1 Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
 - .2 Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum $\frac{1}{2}$ " (13 mm) thick.
 - .3 Fabricate door frames of one-piece construction with edges flanged.
 - .4 Miter and weld perimeter door frames and grind smooth.
 - .5 Cabinet Trim: Fabricate cabinet trim in one (1) piece with corners mitered, welded, and ground smooth.

2.3 GENERAL FINISH REQUIREMENTS

- .1 Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- .2 Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- .3 Finish fire-protection cabinets after assembly.
- .4 Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine roughing-in for hose and cabinets to verify actual locations of piping connections before cabinet installation.
- .2 Examine walls and partitions for suitable framing depth and blocking where cabinets will be installed.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- .1 Prepare substrates for fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- .1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Install cabinets as indicated and in accordance with NFPA 10.

3.4 SITE QUALITY CONTROL

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

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Manufactured metal lockers.

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Provide manufacturer's product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit Shop Drawings stamped and signed by professional engineer registered or licensed in province of Canada.
 - .2 Indicate on Drawings: Type and class of locker, thicknesses of metal, fabricating and assembly methods, tops, ventilation method and finishes.
- .4 Samples:
 - .1 Submit duplicate 2" x 2" samples of colour and finish on actual base metal.
 - .2 Samples will be returned for inclusion into the Work.

1.3 **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 the Project site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground and in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal lockers from nicks, scratches and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 **MATERIALS**

- .1 Locker parts made of galvaneal steel free from surface imperfections and contaminants detrimental to the acceptance of a high-grade hybrid epoxy polyester powder finish.
- .2 Assembly fasteners shall be zinc plated flat head screws with hex nuts. Rivets (Advel #1661-0613) 3/16" aluminum dome head 8-25 dome with steel shaft are also available upon request.

2.2 **LOCKERS**

- .1 Basis of Design:
 - .1 Model "Emperor" lockers as manufactured by Hadrian <https://www.hadrian-inc.com>.
 - .2 Substitutions not permitted.

- .2 Doors:
 - .1 Doors shall be of a double-pan design consisting of a 16-ga outer panel welded to a 24-ga inner panel to form a rigid box construction that resists prying.
 - .2 Outer panel to be double flanged on all four (4) edges and the inner panel single flanged on all four (4) edges, providing rigidity when panels are welded together.
 - .3 A structural and sound deadening 1" cell honeycomb core bonded to the inner surfaces. Door shall be flush with frame and include a recessed handle and recessed number plate, eliminating protruding parts.
 - .4 Doors hinged on the right and swing from left to right.
- .3 Door Frames:
 - .1 Both vertical members shall be not less than 16-ga and formed into a rigid channel 5/8" wide exposed frame and 2 7/16" side depth.
 - .2 Frame shall be completed by 3" high top and bottom cross members of not less than 18-ga formed as an open box channel and welded to the verticals.
 - .3 Bottom frames' full-width lintel extends back and down to form a rigid box to support the bottom shelf.
 - .4 Both vertical frame members shall be formed to full-length 7/16" wide continuous door strike.
 - .5 The latch vertical member shall include a welded 11-ga padlock hasp together with a 7/16" O.D. air-cushioned rubber bumper.
 - .6 No fasteners shall be exposed on fronts of locker doors and frames.
- .4 Body:
 - .1 Sides and backs no less than 24-ga and should not contain extra unnecessary holes unless otherwise specifically used for the assembly of the lockers and accessories on the Project.
 - .2 Edges shall be formed to provide a strong and rigid assembly when bolted or riveted together.
 - .3 Locker backs, flanged at right angles providing a triple thickness of metal at the back corner connections.
 - .4 Shelves, tops and bottoms shall be interchangeable not less than 22-ga and formed into a pan with a lip formed front edge.
- .5 Latching/Locking Device – Single Point:
 - .1 No sliding rods, springs, turnhandles or moving latches.
 - .2 11 ga, 2" x 3/4" padlock hasp securely welded to the continuous strike midway up on the frame and centered at handle location.
 - .3 The hasp shall be formed to protrude through an extruded aluminum recessed handle, cliplocked and bonded to the door.
 - .4 Handle's inner surface shall be concave and grooved for fingertip door control.
 - .5 To keep the door closed when not in use, a 1/2" O.D. nylon friction catch installed on the door to engage the frame in four (4) locations.
 - .6 For built-in locks (combination, key or coin/card operated) replace the hasp with a 11-ga security strike welded to the frame's continuous door strike.

- .7 The lock bolt shall secure itself behind the strike.
- .8 Access to the secured bolt shall be denied by full-length stop on the door frame and by the top lip of the strike projecting forward and fitting into a slot in the door, preventing the door and frame from being pulled apart.
- .6 Hinges: A full-length 18-ga continuous piano hinge shall be securely welded to the frame and fastened to the door with screws or rivets. Hinge shall maximize security and enhance resistance to abuse and vandalism.
- .7 Ventilation: Airflow is achieved through four (4) sets of five (5) unobstructed louvers $\frac{3}{4}$ " wide x $\frac{1}{4}$ " high in the vertical frame members. Provide eighteen (18) each $\frac{3}{16}$ " diameter perforations at outside perimeter of each top, shelf and bottom to offer additional ventilation throughout the inside of each locker.
- .8 Number Plate: Each door shall have a high strength black laminated plastic number plate, 2 $\frac{1}{2}$ " wide x 1 $\frac{1}{8}$ " high with white numbers not less than $\frac{7}{16}$ " high. Plates shall accommodate up to four (4) digits, be nestled in a recess flush with door surface and shall be fastened to door with two (2) rivets. Unless otherwise specified, lockers will be numbered consecutively.
- .9 Interior Equipment: Standard equipment in the double tier lockers shall have three (3) single prong coat hooks per compartment. Double prong coat hooks and 1" O.D. coat rods with stainless steel brackets are available. Hooks are chrome plated steel with ball point heads and attached to shelves with two (2) fasteners.
- .10 Finish: Steel parts and aluminum pedestals shall be thoroughly machine cleaned, phosphatized and finished with a high-performance epoxy powder coating, baked on to provide a uniform, smooth, protective finish. Colors shall be selected from manufacturer's standard color card, including anti-graffiti and special effects colors. Locker frames to be standard as Black #510 unless otherwise selected by the Consultant. Interior body parts are finished in standard Light Grey #535 unless otherwise selected by the Consultant.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 ADJUSTING

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

3.4 CLEANING

- .1 Progress Cleaning:
 - .1 Clean in accordance with Section 01 74 00 - Cleaning and Waste Management.
 - .2 Leave Work area clean at end of each Working Day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning and Waste Management.
- .3 Waste Management:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 00 - Cleaning and Waste Management and Waste Management.
 - .2 Remove recycling containers and bins from Project site and dispose of materials at appropriate facility.

3.5 PROTECTION

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

END OF SECTION

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Psychiatric Seclusion Room Wall Padding: Protective padding (walls, floors, doors and frames) where indicated in Drawings and specified herein.

1.2 **PERFORMANCE REQUIREMENTS**

- .1 Coordination with Building Services and Existing Construction: Provide information to the Contractor to coordinate work by others and enable timely coordination in the field.

1.3 **SUBMITTALS**

- .1 Product Data: For each type of Product to be used, including, but not limited to:
 - .1 Manufacturer's typical details.
 - .2 Thickness of materials.
 - .3 Typical requirements.
 - .4 Material descriptions.
 - .5 Dimensions of individual components and profiles.
 - .6 Finishes.
- .2 Samples: Submit three (3) samples, minimum 3 inches (75 mm) by 3 inches (75 mm).
- .3 Shop Drawings: Include plans, elevations, sections, details and attachments to other work and room numbers using same room numbers indicated on Drawings.
- .4 Warranty: Submit warranty and manufacturers maintenance instructions.

1.4 **QUALITY ASSURANCE**

- .1 Installer Qualifications:
 - .1 Minimum five (5) years of experience with projects of similar scope and performance requirements.
 - .2 Minimum ten (10) successful installations of protective padding.
 - .3 Approved by padding manufacturer.
- .2 Preinstallation Conference: Conduct at Project site minimum one (1) week before installation.
- .3 Maintain minimum temperature of 68°F (20°C) for duration of installation.

1.5 **WARRANTY**

- .1 Manufacturer Warranty:
 - .1 Provide manufacturer's Project-specific warranty, signed by manufacturer and issued in name of Owner and Contractor.
 - .2 Warranty agrees to repair or replace defective material or work including:
 - .1 Loss of adhesion.
 - .2 Loss of resiliency.
 - .3 Delamination.

- .4 Color fade.
- .3 Warranty Period: Minimum ten (10) years.

Part 2 Products

2.1 **PSYCHIATRIC SECLUSION ROOM WALL PADDING**

.1 Description:

- .1 Synthetic resinous material; closed cell polyvinyl chloride or other types of polyvinyl chloride (PVC) surfacing material not acceptable.
- .2 Basis of Design: Gold Medal Safety Padding by Marathon Engineering Corporation.
- .3 Provide Products complying with the following properties:
 - .1 Prefabricated Vertical Panels: Minimum Thickness: Nominal 1" (25 mm) bonded on ½" (13 mm) thick oriented strand board (OSB) for total thickness of 1 ½" (38 mm).
 - .2 Door Jambs: Minimum 1" (25 mm) total thickness.
 - .3 Prefabricated Floor Panels: Minimum Thickness: ¾" (19 mm) safety padding bonded on ½" (13 mm) thick oriented strand board for nominal thickness of 1 ¼" (31 mm) with plus/minus a tolerance of plus/minus 3/16" (4.8 mm).
 - .4 Physical Properties:
 - .1 Fire Resistance:
 - .1 ASTM E84 Class A.
 - .2 Flame Spread 5.
 - .3 Smoke Development 20.
 - .2 Tensile Strength: 300 PSI minimum per ASTM D412.
 - .3 Temperature Stability: Unaffected from minus 20°F (7°C) to plus 120°F (48°C).
 - .4 Moisture Absorption: 0.8% to 1.05% by weight.
 - .5 Compression Set: 90% recovery after seventy-two (72) hours.
 - .6 Compression Properties: 30 PSI to 70 PSI at 50% modulus.
 - .7 Elongation at Break: 150% typical to ASTM D412.
 - .8 Critical Radiant Flux: >0.99 W/cm² to ASTM E684, Class I.
 - .9 Acute Oral Toxicity Test: Non-Toxic.
 - .10 Hardness: 60 (plus or minus 5) durometer.
 - .11 Fungus Resistance (MIL-I-531-D): Completely Resistant Rating (0.0.0).
 - .5 Fasteners: Recommended by padding manufacturer. Provided with fasteners, sealants, grout and other materials required to ensure complete installation.

Part 3 Execution

3.1 **EXAMINATION**

- .1 Inspect substrates to receive wall padding.
- .2 Notify Contractor and the Consultant in writing if substrates are not satisfactory for application of materials.
- .3 Do not proceed until unsatisfactory substrates are corrected. Commencement of padding installation constitutes acceptance of substrates.

3.2 **INSTALLATION**

- .1 Mechanically fasten vertical panels to walls, leaving 0.118" (3 mm) plus/minus 0.078" (2 mm) between panels.
- .2 Fill with manufacturer's compound and allow to cure in accordance with manufacturer's instructions.
- .3 Sand compound to meet adjacent edges.
- .4 Fill fastener holes, allow to cure and sand.
- .5 Install manufacturers topcoat.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Part 1 General

1.1 **SECTION INCLUDES**

- .1 Solid surface material countertops.

1.2 **ACTION SUBMITTALS**

- .1 Product Data: For countertop materials.
- .2 Sustainable Design Submittals:
 - .1 Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - .2 Product Data: For adhesives, indicating VOC content.
 - .3 Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - .4 Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
 - .5 Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
- .3 Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - .1 Show locations and details of joints.
 - .2 Show direction of directional pattern, if any.
- .4 Samples for Initial Selection: For each type of material exposed to view.
- .5 Samples for Verification: For the following products:
 - .1 Countertop material, 6" square.
 - .2 Wood trim, 8" long.
 - .3 One full-size solid surface material countertop, with front edge and backsplash where indicated on the Drawings, 8" x 10" of construction and in configuration specified.

1.3 **INFORMATIONAL SUBMITTALS**

- .1 Qualification Data: For fabricator.

1.4 **CLOSEOUT SUBMITTALS**

- .1 Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 **QUALITY ASSURANCE**

- .1 Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- .2 Installer Qualifications: Fabricator of countertops.

- .3 Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - .1 Build mockup of typical countertop as shown on Drawings.
 - .2 Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

- .1 Field Measurements: Verify dimensions before countertop fabrication is complete.

1.7 COORDINATION

- .1 Coordinate locations of utilities that will penetrate countertops or backsplashes.

Part 2 Products

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- .1 Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - .1 Basis-of-Design Products: Subject to compliance with requirements, provide products by LX Hausys <https://www.lxhausys.com>.
 - .2 Subject to compliance with requirements, provide products indicated Drawings.
 - .3 Type: Provide Standard type unless Special Purpose type is indicated.
 - .4 Colors and Patterns: As selected by Consultant from manufacturer's full range.

2.2 COUNTERTOP FABRICATION

- .1 Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
- .2 Grade: Premium.
- .3 Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - .1 Fabricate with loose backsplashes for field assembly.
 - .2 Install integral sink bowls in countertops in the shop.
- .4 Joints: Fabricate countertops without joints.
- .5 Cutouts and Holes:
 - .1 Undercounter Plumbing Fixtures: Make cutouts for fixtures [**in shop**] using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - .1 Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16" into fixture opening.
 - .2 Provide vertical edges, rounded to 3/8" radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16" into fixture opening.

- .3 Provide ¾" full bullnose edges projecting 3/8" into fixture opening.
- .2 Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
- .3 Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
- .4 Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.3 **INSTALLATION MATERIALS**

- .1 Adhesive: Product recommended by solid surface material manufacturer.
 - .1 Adhesives shall have a VOC content of 70 g/L or less.
 - .2 Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- .2 Sealant: Comply with applicable requirements in Section 07 92 00 - Joint Sealants.

Part 3 **Execution**

3.1 **EXAMINATION**

- .1 Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **INSTALLATION**

- .1 Install countertops level to a tolerance of 1/8" in 8'-0", ¼" maximum. Do not exceed 1/64" difference between planes of adjacent units.
- .2 Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- .3 Fasten sub-tops to cabinets by screwing through sub-tops into corner-blocks of base cabinets. Shim as needed to align sub-tops in a level plane.
- .4 Secure countertops to sub-tops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- .5 Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - .1 Install metal splines in kerfs in countertop edges at joints where indicated. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.

- .2 Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- .6 Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- .7 Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- .8 Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- .1 Seal edges of cutouts in particleboard sub-tops by saturating with varnish.
- .9 Apply sealant to gaps at walls; comply with Section 07 92 00 - Joint Sealants.

END OF SECTION



**Discipline: Mechanical
Specification
FOR**

**WAYPOINT CENTRE FOR MENTAL HEALTHCARE
Toanche Building 3rd Floor Renovation Project
Penetanguishene, ON, Canada**

Issued for Tender
12/18/2023

HHA #2211105

PRIME CONSULTANT:
CannonDesign
50 Fountain Plaza, Suite 200
Buffalo, NY 14202
Cannon # 020708.51

1127 Leslie Street
Don Mills, Ontario
M3C 2J6

T. (1) 416.443.8200
F. (1) 416.443.8290
www.hhangus.com

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

00 01 10

1 GENERAL

1.1 Scope

- .1 List of documents in the project manual, excluding drawings bound separately from this manual.

2 SPECIFICATIONS

DIVISIONS 20 TO 25 – MECHANICAL

Division 20 – Mechanical Common Work

20 01 01	Mechanical General Requirements
20 01 02.ON	Qualifications and Authorities – Ontario
20 01 13	Definitions and Abbreviations
20 05 01	Basic Materials and Methods
20 05 02	Painting for Mechanical Services
20 05 12	Common Electrical Requirements for Mechanical Services
20 05 13	Common Motor Requirements for Mechanical Equipment
20 05 14.13	Constant Speed Motor Controllers
20 05 16	Flex Connections, Expansion Joints, Anchors & Guides
20 05 19	Indicating Gauges
20 05 23	General Requirements for Valves
20 05 24	Welding and Brazing
20 05 29	Common Hanger and Support Requirements for Piping
20 05 48	Vibration Isolation
20 05 49	Seismic Restraint for Mechanical Services
20 05 53	Identification for Mechanical Services
20 05 73.13	Mechanical Services for General Facility Equipment
20 07 11	Common Requirements for Mechanical Insulation
20 07 13	Ductwork Insulation
20 07 16	Equipment Insulation
20 07 19	Piping Insulation
20 77 19.20	Closeout Requirements for Mechanical Work CCDC 2020

Division 22 – Plumbing and Drainage

22 05 01	Common Work Results for Plumbing
22 05 23.13	General Duty valves for Plumbing Piping
22 05 93	Testing Adjusting and Balancing for Plumbing
22 11 16.13	Domestic Water Piping – Copper
22 11 19	Domestic Water Piping Specialties
22 13 16.13	Sanitary Waste and Vent Piping – Cast Iron and Copper
22 13 19.13	Sanitary Drains

22 42 00	Plumbing Fixtures
22 45 00	Emergency Plumbing Fixtures

Division 23 – HVAC

23 05 01	HVAC Piping Systems General Requirements
23 05 23.13	General Duty Valves for HVAC Water Piping
23 05 93.13	Testing Adjusting and Balancing for HVAC
23 05 93.23	TAB Supplement for Healthcare
23 21 13.23	Hydronic Piping – Carbon Steel
23 21 13.33	Hydronic Piping – Copper
23 21 16	Hydronic Piping Specialties
23 31 01	Air Distribution - General
23 31 13.13	Metal Ducts
23 33 05	Duct Accessories
23 33 13.11	Manual Balancing Dampers
23 33 13.13	Control Dampers
23 33 13.16	Fire and Smoke Dampers
23 33 13.23	Backdraft Dampers
23 33 16	Flexible Ducts
23 33 19	Duct Silencers
23 33 63	Louvres
23 34 16	HVAC Fans
23 37 13	Grilles, Registers and Diffusers
23 41 11	Particulate Air Filters
23 82 23	Fan Coil Units
23 83 16	Radiant Ceiling Panels

Division 25 – Controls and Automation

25 05 01	Building Automation Common Work Results
25 05 06	Work on Existing Building Automation Systems
25 05 12	Building Automation Control Panels and Wiring
25 30 13	Building Automation Actuators and Operators
25 30 16.13	Building Automation Instrumentation
25 30 19.13	Building Automation Control Valves
25 30 23.13	Building Automation Control Dampers
25 90 01	Building Automation Control Sequences

End of Section

MECHANICAL GENERAL REQUIREMENTS

20 01 01

1 GENERAL

1.1 General Contract Documents

- .1 Comply with General Conditions of the Contract, Supplementary Conditions of the Contract, and Division 01 - General Requirements.
- .2 Where content in this Specification section duplicates requirements in various Division 01 Specification sections, this section and the applicable Division 01 sections are to be read together and the most stringent requirements apply.

1.2 Work Included

- .1 Work to be done under Divisions 20, 21, 22, 23 and 25 to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete mechanical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.
- .2 Read drawings and specifications together as a whole and in conjunction with other such documents included under the Construction Contract.

1.3 Document Organization

- .1 Applicable Divisions for Mechanical Work:
 - .1 Division 20 - Common Work for Mechanical
 - .2 Division 21 - Fire Protection
 - .3 Division 22 - Plumbing and Drainage
 - .4 Division 23 - Heating, Ventilation and Air Conditioning (HVAC)
 - .5 Division 25 - Building Automation System
- .2 For clarity, any reference in the Contract Documents to Division 20 includes Divisions 21, 22, 23 and 25.
- .3 The Specifications for these Divisions are arranged in sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .4 Contractor is responsible for completion of work whether or not portions are sublet.

1.4 Division 20, as it applies to Divisions 21, 22, 23 and 25

- .1 Division 20 contains common work requirements that are applicable as necessary to the Work of Divisions 21 to 25 and apply as if written in full within those Divisions.

1.5 Language

- .1 The specification is written as a series of instructions addressed to the Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where a list follows a semi-colon (;) the punctuation is for clarity. Where a list follows a colon (:) the punctuation is to be read as a short-hand form of the verb "to be" or "to have" as context requires.
- .2 It is not intended to debate with the Contractor the reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

1.6 Definitions and Abbreviations

- .1 Specification section 20 01 13 *Definitions and Abbreviations – Mechanical* contains general definitions and abbreviations that apply to one or more specification sections of this Division of the Work. Other specification sections of the mechanical Divisions of the Work may also include additional specific definitions and/or abbreviations that apply to that specification section.
- .2 The following general terms apply to Divisions 20 to 25 of the Work:
 - .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in this Specification, mean that material or item referred to is "indicated", "shown", "listed" or "noted" on Drawings or in Specification.
 - .2 Wherever the word "listed" is used in conjunction with a product and a product certification standard (including but not limited to CSA, ULC, CGSB, BNQ, UL), it shall be understood to mean that the product is "listed" by an accredited 3rd party testing laboratory as being certified to the referenced product standard.
 - .3 Wherever the words "approved", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "approved by" the Owner.
 - .4 Wherever the words "satisfactory", "as directed", "submit", "permitted", "reviewed", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "satisfactory to", "as directed by", "submitted to", "permitted by", or "reviewed by" the Consultant.
 - .5 Instructions using any form of the word:
 - (a) "install" means to place in position and activate for service or use,
 - (b) "supply" means to procure and deliver materials to the place of the Work, or to make available labour or services for the stated purpose,
 - (c) "provide" means to supply material, labour and services to install the referenced item.
 - .6 The term "building code" means the edition of the applicable building code at the time of obtaining a building permit.
 - .7 Wherever manufacturers or manufacturer's products are identified in lists under the phrase "Standard of Acceptance", these are manufacturers and/or products which meet the project standards in regard to performance, quality of material and workmanship.

1.7 Examination

- .1 Examine any existing buildings, local conditions, building site, the specifications and drawings, and report any condition, defect or interference that would prevent execution of the work.
- .2 No allowance will be made for any expense incurred through failure to make these examinations of the site and the documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.
- .3 Before commencing work under this Division, examine the work of other Divisions of the Work and report any defect or interference.

1.8 Design Services

- .1 Provide specialty design services for elements of the Work where specified in other sections of Division 20. Drawings and specifications prepared by such specialty design service providers shall be sealed by a professional engineer licensed in the jurisdiction of the Work.

1.9 Product Substitutions

- .1 The use of a substitute article or material which the manufacturer represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions:
 - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the contractor can demonstrate to the satisfaction of the Consultant they made all reasonable efforts to procure the specified product or material in a timely fashion,
 - .2 the manufacturer must advise the Consultant of this intention to use an alternative article or material before doing so,
 - .3 the burden of proof as to the quality and suitability of alternatives to be upon the manufacturer and they shall supply all information necessary as required by the Consultant at no additional costs to the contract,
 - .4 the Consultant shall be the sole judge as to the quality and suitability of alternative materials and their decision to be final,
 - .5 where use of an alternative material involves redesign or changes to other parts of the work, the costs and the time required to effect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
 - .6 no test or action relating to the approval of substitute materials is to be made until the request for substitution has been made in writing by the manufacturer and has been accompanied by complete data as to the quality of the materials proposed. Such request to be made in ample time to permit appropriate review without delaying the work, taking into consideration that such a substitution request may be rejected and require providing the product or material as originally specified,
 - .7 whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials is to be accompanied by reports from the equivalent body indicating compliance with the requirements of the specifications,
 - .8 the costs of all testing required to prove equality of the material proposed to be borne by the manufacturer.

2 SHIPPING, HANDLING AND STORAGE

2.1 Shipping

- .1 Provide adequate protection of equipment during shipping and handling so as to provide equipment at the Work site in ex-works condition when handled by commercial carrier systems.
- .2 Provide, as necessary, removable bracing of the internal components in each item of equipment so that the equipment can be moved on its side or back, without sustaining damage.
- .3 Where removeable internal bracing has been provided, the equipment to be provided with warning labels to call for the removal of the shipping bracing prior to energization.
- .4 Any component that is packaged or shipped separately is to be individually crated and tagged with unit number and the equipment number of the assembly to which it belongs.
- .5 Provide each "shipping section" with a permanently-attached, readily-visible identification tag bearing the equipment number of the assembly of which it is a part.

2.2 Storage

- .1 Store equipment and materials at the worksite to protect them from any damage until placed into its final location. Maintain similar protection of installed equipment and materials to protect against damage

until they are turned over to the Owner. Make good any damage to equipment or materials up to the time of ready for takeover.

- .2 Store mechanical equipment in a dry, clean location and cover with polyethylene plastic sheeting to preserve factory finish.
- .3 Provide adequate ventilation and temporary heating to prevent condensation of moisture within the equipment.

2.3 Provisions for Handling and Field Erection

- .1 For equipment that will require hoisting on site, provide removable side panels, lifting angles or lifting plates to accommodate the use of slings or crane hooks, for each shipping section.
- .2 For floor mounted equipment, provide on each shipping section removable steel channel base plates to permit use of pipe rollers or dollies without damaging the equipment.

3 OWNER'S SPECIAL REQUIREMENTS FOR EXISTING SITES

- .1 The following special requirements are in addition to the requirements of Division 01 of the Work.
- .2 Provide a written list of names for employees and sub-trades entering the building, advising which areas they need access to at least 48 hours prior to expected time of arrival. This lead time is required to prearrange security passes.
- .3 Security passes must be visibly worn at all times by all employees.
- .4 Trades people to strictly adhere to owner's building security procedures otherwise entrance into the building will be denied.
- .5 Trades people are to enter the entrance identified by the Owner.
- .6 Park vehicles in designated areas. Do not block driveways.
- .7 Use only the freight elevator to transport tools and material. Freight elevator door must be shut immediately after exiting the cab.
- .8 Do not disable or activate any electrical or mechanical system without prior approval by the Owner's Project Manager. Also, prior to disabling or activation of any electrical or mechanical system, obtain approval from Building Operations and Building Security.
- .9 Submit prior notification to Building Security Staff before any construction activity commences which will result in heat, smoke, dust or fumes, such as welding, saw cutting, soldering, spray painting, which might affect sensitive fire detection and protection equipment.
- .10 Provide at least 48 hours prior notification to Building Operations for any fire system isolation requests.
- .11 Schedule work and meet with sub-trades daily on site, to show trades people the work areas and work to be done.
- .12 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned by the Owner.
- .13 Provide environmental cleaning of the job site daily during construction and upon completion. This includes above ceilings. Do not store materials or garbage on the loading dock.
- .14 Provide special care, attention and protection when transporting equipment and materials to prevent accidental damage to fire protection equipment, finishes, furnishings and fixtures.
- .15 "No Smoking" – this is a smoke-free building. Violators will be asked to leave and may be denied reentry. Smoking is not allowed on the roof.

- .16 A security escort will be required for any work being done in secured areas, e.g. raised floor, computer room and mechanical/electrical rooms.
- .17 If Building Operations deems that work on a particular system requires security escort, allow 48 hours to make appropriate arrangements.
- .18 For any open flame work, provide fire extinguishers and security fire watch.
- .19 Obtain the approval of the Building Manager for the storage of materials on site.
- .20 Perform a daily cleanup prior to leaving the site.
- .21 Secure oxygen and acetylene cylinders at all times and capped nightly.
- .22 Restore operating and redundant systems to their normal condition at the end of each work day unless otherwise approved by the Owner
- .23 At the conclusion of each work day, the Contractor's superintendent/supervisor is to advise the Building Manager on the day's activities and plans for the next day's work.

4 PROGRESS PAYMENT PROCEDURE

4.1 Schedule of Values

- .1 Provide schedule(s) of values for progress payments in accordance with this part.
- .2 Prepare and submit a schedule of values ("SOV") for the Division 20 Work.
- .3 Each SOV is to be in the sample format shown in Article "Attachments", specifically that the SOV is to include four sections for:
 - .1 Contract price work element breakdown, which includes:
 - (a) detailed breakdown by work element as agreed with the Consultant,
 - (b) line items for coordination drawings, as-built documents and operating manuals,
 - (c) a summary line item for authorized Cash Allowance disbursements (if applicable),
 - (d) line items for each Itemized Price (if applicable),
 - (e) line items for each Separate Price (if applicable and included in the Contract Price)
 - (f) a line item for the total of the original contract work element values,
 - (g) a summary line item for approved change instructions,
 - .2 Cash Allowance disbursement authorization, with separate work elements for each cash allowance,
 - .3 Approved Change Instructions, with separate work elements for each change instruction,
 - .4 Outstanding Change Instructions which are either not quoted or not yet approved.
- .4 Each work element in the SOV sections (except Outstanding Change Instructions) is to include:
 - .1 the original contract value and the percent of original contract total value (Contract Price section only),
 - .2 the completed to date amount and percent of original work element contract value,
 - .3 the previously billed amount and percent of original work element contract value,
 - .4 the current billing (payment request) amount and percent of original work element contract value, and
 - .5 the balance to complete amount and percentage of original work element contract value.

- .5 The required Contract Price work element breakdown will be determined by the Consultant, with the level of breakdown appropriate to the project such as
 - .1 by trade,
 - .2 by specification section or portion thereof,
 - .3 by labour vs material,
 - .4 by location in the building,
 - .5 or any combination of the above.
- .6 Submit a draft SOV for review and approval by the Consultant at least three weeks before the first request for progress payment. Do not submit requests for progress payments until the SOV has been reviewed and there are no outstanding comments from the Consultant.
- .7 Make requests for progress payments using the values on the reviewed SOV.
- .8 When a change in the Work has been approved by the Owner, include the approved changes on the SOV for the next payment application, whether or not payment is requested in full or in part for that change in that payment request period.

5 CONSTRUCTION CHANGES

5.1 General

- .1 The valuation method to be used for a change instruction to the Work is to be determined by the Consultant from the following methods:
 - .1 by labour and material when the change instruction is by a Change Directive;
 - .2 by unit prices set out in the Contract or subsequently agreed upon for other change instructions;
 - .3 by a detailed quotation for other change instructions; or
 - .4 by a Cash Allowance Disbursement instruction.

5.2 Definitions

- .1 The following definitions apply to this section
 - .1 **RS Means manual** – the trade pricing reference book published by Gordian Group Inc. that is applicable to the jurisdiction of the project.
 - .2 **Base wage rate** – the hourly rate actually paid to the trades person, determined in accordance with applicable collective bargaining agreement, or in their absence the actual gross wages paid to the worker.
 - .3 **Job Site Impact Multiplier** – a multiplier expressed as a decimal number that is included in the Labour Rate to account for special job site conditions that affect labour availability, labour productivity, procurement of materials, and materials management, that are specific to the project and site conditions.
 - .4 **Indirect labour** – any labour that is neither journey person labour that directly performs the work nor labour that directly supervises journey person(s).
 - .5 **Labour Rate** – the actual fully burdened labour cost per hour of labour consumed by a trades person including statutory and regulatory burden, collective bargaining burden, and other project related burden. For greater clarity, the labour rate includes but is not limited to the following:
 - (a) base wage rate,
 - (b) vacation and statutory holiday pay,

- (c) union deductions and additional union charges,
 - (d) Legislated burdens including EHT, WSIB, EI, CPP, RST on H/W
 - (e) wage-based taxes,
 - (f) job site impact multipliers,
 - (g) expendable small tools charge,
 - (h) project insurance,
 - (i) financing of payroll,
 - (j) estimating,
 - (k) rest breaks and idle time,
 - (l) safety including training, safety meetings, WHMIS, fall protection, personnel protection equipment, and safety committees,
 - (m) preparation and handling of shop drawings and other submittals,
 - (n) preparation of as-built documents, including operation and maintenance manuals,
 - (o) labour warranties,
 - (p) site facilities,
 - (q) clean-up,
 - (r) parking.
- .6 **Foreperson** – a first level supervisory position having direct control over the work performed by journeypersons.
- .7 **Journey person** – a person working in a skilled construction trade which may be prescribed by regulation, and includes apprentices.
- .8 **Labour Unit** – the number of journey person labour hours or part thereof, required to perform a specific construction task, and includes but is not limited to:
- (a) receiving, unloading, stockpiling, distribution and handling of materials and equipment,
 - (b) rigging or erecting of materials or equipment,
 - (c) fitting and joining of materials,
 - (d) pressure testing of piping and ductwork systems,
 - (e) testing of equipment and systems.
- .9 **Line materials** – components that make up a distribution network for fluid, power, or electronic/digital information, and includes:
- (a) piping, pipe fittings, valves (of all kinds), pipe strainers and other pipe mounted equipment,
 - (b) ducting, duct fittings, duct balancing dampers and other duct mounted equipment,
 - (c) conduit, cable tray, cable, conductors, and wiring,
 - (d) supports, hangers and restraints,
 - (e) vibration isolators and seismic restraints associated with line materials,
 - (f) instrumentation including gauges and sensors/transmitters,
 - (g) electrical, pneumatic, and hydraulic actuators for valves and dampers, and
 - (h) any coatings or other protective elements applied thereto including insulation and painting.
- .10 **Overhead** – administrative expenses of the Contractor's business and the project which are not included in a Labour Rate or Labour Unit. For greater clarity, overhead includes but is not limited to the following:

- (a) company office, storage, and fabrication spaces, and associated maintenance, utilities, and expenses,
- (b) project site office, fabrication and storage spaces, washrooms, break rooms, and associated maintenance, utilities, and expenses,
- (c) company office equipment, furniture and supplies,
- (d) project site office equipment, furniture and supplies,
- (e) labour time for project managers and project assistants,
- (f) project site security,
- (g) project site clean-up, recycling and waste disposal,
- (h) materials management,
- (i) property taxes, business licenses, and auto insurance,
- (j) dues and subscriptions,
- (k) postage and courier,
- (l) advertising, telephone, IT services and equipment,
- (m) legal and accounting fees and expenses,
- (n) sales and marketing,
- (o) salaries and benefits for company indirect labour including company management, sales force, dispatchers, estimators, clerical staff, and at-office general (non-trades) labour.
- (p) all other indirect labour.

.11 Senior Foreperson – the second (and subsequent) level supervisory position having direct control over one or more Forepersons, where the number of Forepersons supervised is in accordance with local regulatory requirements or collective bargaining agreements. (“Superintendent” or “Supervisor” has the same meaning.

5.3 Change Directive Method

- .1 Except where otherwise determined in the Construction Contract or Division 01 specification, the valuation of changes by the Change Directive method shall comply with the following:
 - .1 the form of presentation of costs and methods of measurement shall be agreed to by Consultant and Contractor before proceeding with the change,
 - .2 the adjustment in the Contract Price for a change carried out by way of Change Directive shall be determined on the basis of the cost of the Contractor’s actual expenditures and savings attributed to the Change Directive. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
 - .3 labour costs will be determined based on actual time spent and the agreed labour rate, the actual cost of installed line materials and equipment, and the agreed fee for overhead and profit,
 - .4 if the change results in a net decrease in Contract cost, the contract price will be decreased by the net decrease in the cost, without adjustment for the Contractor’s percentage fee for overhead and profit,
 - .5 the Contractor shall keep accurate records, in an agreed upon form, of time, quantities and invoiced costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices,
 - .6 this time and material method shall be used until such time as a total cost estimate of the change is agreed between the Owner and the Contractor, at which time all payments made under this time and material method will be credited against the agreed total cost for the change.

5.4 Unit Price Method

- .1 Costing of changes by the Unit Price method:
 - .1 Costs for work identified by agreed unit costs shall be charged at those rates, unless the Owner agrees to other rates.

5.5 Proposed Changes; Other Change Instructions Method

- .1 For proposed changes to the Work or other similar instructions, submit a detailed quotation for approval.
- .2 The adjustment in the Contract Price for a change carried out by way of proposed change or other similar instruction shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Proposed Change. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
- .3 Costs are to be approved by the Owner before the proposed change to the Work proceeds. The quotation for the change to the Work is to include a summary of charges made up of three components: labour charges, material costs and fees.
- .4 Labour Charges:
 - .1 The labour unit hour estimates are to be based on the current RS Means estimating manual unless otherwise agreed by the Consultant;
 - .2 The labour cost is to be determined using the agreed labour rates.
 - .3 Labour rates for Foreperson and Senior Foreperson shall be as per agreement, or in absence of such agreement shall be 1.15 times the journeyman labour rate. The maximum allowable labour hours for supervision are not to exceed:
 - (a) for a Foreperson, a maximum of 10% of the total calculated journeyman hours on a change, and
 - (b) for a Senior Foreperson of all levels, a maximum combined amount of 3% of the total calculated journeyman hours on a change.
 - (c) no other supervisory hours will be permitted.
- .5 Material Charges:
 - .1 Material costs for line materials and installed equipment are to be net of trade discounts. The discount to be applied to list prices for items included in RS Means manual shall not be less than:
 - (a) 20% for line materials, and
 - (b) 10% for equipment that is not line material.
- .6 Fees:
 - .1 Refer to Division 01 regarding fees for overhead and profit on changes to the Work
 - .2 The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 15% for work to be performed by their own forces,
 - .3 The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 5% for work performed by a sub-contractor (in the case of the Contractor) or a sub-sub-contractor (in the case of work performed for a sub-contractor),
 - .4 For clarity, the allowable fees on direct work and on sub-contracted work apply to a sub-sub-contractor of any tier.

5.6 Cash Allowances; Contingency Allowances

- .1 Instructions for changes to the Work to be performed under a cash allowance or contingency allowance ("Allowance") included in the contract price shall be authorized by a Cash Allowance Disbursement instruction.
- .2 Except as described below, the determination of costs for Work performed under an Allowance shall be in accordance with the procedure for proposed changes unless otherwise instructed to proceed with the work, in which case the cost of such work shall be valued in accordance with the procedures for Change Directive.
- .3 The contract price, not the Allowance, includes the overhead and profit fee for the value of the Allowance.
- .4 Except where otherwise specified in the Construction Contract, where the cost of the Work performed under a Cash Allowance Authorization;
 - .1 is less than the Allowance value, the contract price includes the overhead and profit for the contractor and any sub-contractors. A change order will be issued for a credit for the balance of the Allowance, but shall not include the associated overhead and profit fee.
 - .2 exceeds the Allowance value, a Change Order will be issued for the amount in excess of the Allowance, and the excess amount is to include the agreed fee for overhead and profit.

6 SUBMITTALS

6.1 Shop Drawings and Product Data Sheets

- .1 Submit shop drawings, manufacturers product data and samples in accordance with the requirements of Specification sections of Division 01, this Part, and as further required in other Specification sections of Division 20.
- .2 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and U.S. customary units may be included.
- .3 Submit shop drawings by email to: shopdrawings@hhangus.com, except where a project document management web-service is used.
- .4 Include a H.H. Angus shop drawing cover sheet form prepared for this project for each shop drawing submittal (refer to part "Attachments" for an example of this form) , or include the same information on the general or trade contractor's submittal cover sheet;
 - .1 Information required on each submission:
 - (a) Client/Architect name,
 - (b) Project Name,
 - (c) H.H. Angus project number,
 - (d) Date,
 - (e) Contractor name,
 - (f) Contractor reference No.,
 - (g) Manufacturer name,
 - (h) Product type,
 - (i) Specification section number,
 - (j) Contractor trade category: architectural, structural, conveying equipment, user equipment, mechanical, electrical, telecommunications, civil or other.
 - (k) If a re-submission, the Consultant's previous submittal reference number.

- .5 Submit shop drawings in PDF format except as follows;
 - .1 if the Consultant agrees to a shop drawing to be submitted in hardcopy format, submit in 8.5 x 11 or 11 x 17 size, black and white originals of graphic quality suitable for photocopying and digital scanning. Allow one additional week for processing of shop drawings submitted in hardcopy format.
- .6 Manufacturer's letter sized product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.
- .7 Submit with manufacturers data sheets, typed schedules listing manufacturer's and supplier's name and catalogue model number.
- .8 For plumbing fixtures and other permeant fixtures, submit fixture sheets with catalogue numbers. Identify and arrange fixture sheets in the same sequence and using the same identification number as shown in specification fixture lists.
- .9 Shop drawings and/or product data sheets to show;
 - (a) dimensioned outlines of equipment and construction details,
 - (b) equipment weights and center of gravity,
 - (c) performance ratings,
 - (d) dimensioned details showing service connection points,
 - (e) elevations illustrating locations of visible equipment such as gauges, pilot lights, breakers and their trip settings, windows, meters, and access doors,
 - (f) description of operation,
 - (g) single line diagrams,
 - (h) general routing of bus ducts and connecting services,
 - (i) mounting and fixing arrangements,
 - (j) operating and maintenance clearances,
 - (k) access door swing spaces, and
 - (l) where products are required to be certified to a published standard, the mark of the testing organization who certified the product and the standard reference number to which it is certified.
- .10 Shop drawings and product data to be accompanied by;
 - (a) detailed drawings of bases, supports and anchor bolts,
 - (b) sound power data, where applicable, and
 - (c) performance curve for each piece of equipment marked with point of operation.
- .11 Shop drawing and data sheet submission is taken as certification that the products are;
 - .1 from the manufacturer's current production, and
 - .2 in compliance with applicable codes, standards, and regulations.
- .12 For standard catalogued (non-custom) products, do not submit drawings showing internal construction details, component assemblies or interior piping and wiring diagrams. Such information may be necessary to understand correct functioning of equipment and are to be submitted with operating and maintenance data.
- .13 Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.
- .14 Keep one copy of each reviewed shop drawing and product data sheet on site and have them available for reference purposes.

- .15 Where equipment is delivered without reviewed shop drawings, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawings have been submitted and reviewed.

6.2 Coordination, Fabrication, or Installation Drawings

- .1 Contractor coordination, fabrication, installation and/or sleeving drawings are to be provided in accordance with specification Section 20 01 03 *Mechanical Coordination and Installation Design Services*.
- .2 Contractor's coordination, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal only will be returned identifying the submitted drawings have not been reviewed as a shop drawing.
- .3 Maintain a copy on site of such drawings for reference by the Consultant.
- .4 The Consultant reserves the right to request selected Contractor's coordination, fabrication, or installation drawings for review.

6.3 Effect of Consultants Review of Submittals

- .1 Consultant's review of shop drawings is performed on a sampling basis only, to confirm to Consultant's satisfaction that the Contractor understands the Work to be performed and is interpreting the design documents correctly, and such reviews are performed for the benefit of the Owner.
- .2 For greater certainty, the review of shop drawings by Consultant does not constitute a quality control function for the benefit of Contractor, nor does such a review relieve Contractor of their responsibility for complying with the Contract documents.

7 APPLICABLE CODES, STANDARDS AND REGULATIONS; PERMITS

7.1 Codes, Standards and Regulations

- .1 Where a published product standard or installation code is adopted by statute or regulation by an applicable AHJ, the applicable edition of the standard or code is the one that has been adopted
 - .1 at the time of obtaining a permit for the applicable portion of the Work, or
 - .2 in the absence of a requirement for a permit, the start date of construction.
- .2 Where a published product standard or installation code is not adopted by statute or regulation, then the most current edition of that standard or code at the start date of construction applies.
- .3 Install mechanical and electrical systems in accordance with the applicable requirements adopted by the AHJ in the jurisdiction of the Work.
- .4 Where requirements of the Specifications exceed those of applicable codes, standards, and regulations the requirements of the Specifications is to govern.
- .5 In the event of a conflict between codes, bulletins, regulations, or standards, or where work shown is in conflict with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring application of the most demanding requirements.

7.2 Confined Spaces

- .1 Unless otherwise prescribed by the Constructor's / Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as confined spaces in accordance with applicable health and safety legislation, including but not limited to:
 - .1 horizontal and vertical service spaces, shafts, and tunnels,

- .2 inside of equipment which permits entry of the head and/or whole body, and
- .3 ceiling spaces which are identified as containing a hazardous substance.

7.3 Permits, Tests and Certificates

- .1 Arrange and pay for permits, tests, and Certificates of Inspection required by the AHJ applicable to the element of the Work.
- .2 Submit applications requiring Owner's signature before commencing work.
- .3 Obtain and submit applicable AHJ Inspection certificates or reports including but not limited to:
 - (a) Electrical inspection,
 - (b) Plumbing and drainage inspection,
 - (c) HVAC inspection,
 - (d) Pressure Vessel Inspection.
 - (e) Piping and Boiler Inspection.
 - (f) Fuel safety Inspection.
- .2 Renew certificates or reports so as to remain in force through the warranty period.
- .4 Co-ordinate and perform testing required by an AHJ in accordance with the Part on Testing in this Section.

8 COMMON PRODUCT REQUIREMENTS

8.1 Standard of Material and Equipment

- .1 Provide materials and equipment in accordance the requirements of Specification section of Division 01 and as follows.
- .2 Materials and equipment:
 - .1 new and of uniform pattern throughout work,
 - .2 of Canadian manufacture where obtainable,
 - .3 standard products of approved manufacture,
 - .4 labeled or listed (certified) to applicable standards in accordance with Specification sections of the Work and as required by authorities having jurisdiction,
 - .5 registered in accordance with the requirements of the applicable provincial pressure vessels regulation and registered in accordance with CSA B51 for Canadian Registration Numbers, as applicable,
 - .6 in compliance with Standards and Regulations including but not limited to;
 - (a) chemical and physical properties of materials,
 - (b) design,
 - (c) performance characteristics, and
 - (d) methods of construction and installation.
 - .7 identical units of equipment to be by the same manufacturer. ,
 - .8 identical component parts of same manufacturer in similar units of equipment, but various component parts of each unit need not be from one manufacturer.
- .3 Materials and equipment are described to establish standards of construction and workmanship. Where manufacturers and/or products are listed under "Standard of Acceptance", select manufacturers and or

products from these lists. Use of manufacturers or products other than as listed are subject to specification requirements concerning requests for substitution.

- .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make a complete and operating system.
- .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.
- .6 Factory fabricated control panels and component assemblies are to be listed for electrical safety requirements.
- .7 Select materials and equipment in accordance with manufacturer's recommendations and these Specifications, and install same in accordance with manufacturer's instructions and these Specifications.
- .8 Materials and equipment not satisfying these selection criteria will be condemned. Remove condemned materials from job site and provide properly selected and approved materials.

8.2 Manufacturers Nameplates

- .1 Provide manufactured equipment with metal nameplate with raised or recessed lettering, mounted on each piece of equipment. On insulated equipment, mechanically fasten plates on metal stand-off bracket arranged to clear insulation.
- .2 Manufacturer's nameplate to indicate equipment size, capacity, model designation, manufacturer's name, serial number, voltage, cycle, phase and power rating of motors, and approval listings.
- .3 Certified products are to clearly show the mark of the certification agency when in the final installed state.

8.3 Factory Applied Painting

- .1 Protect factory finished equipment during construction, and clean at completion of work.
- .2 Touch-up factory painted prime and/or final coats damaged during construction, with colour matching paint recommended by the equipment manufacturer.
- .3 Use heat resistant paint where conditions require.

8.4 Factory Applied Prime Painting

- .1 Factory-prime paint other equipment fabricated from iron or steel, including equipment supports and hangers, access platforms, access doors, registers, grilles, diffusers, dampers, metal radiation enclosures and fire hose cabinets where separate product specifications do not require a factory applied final coat.

8.5 Field Painting

- .1 After equipment has been installed and piping and insulation is completed, clean rust and oil from exposed iron and steel work provided under this Division, whether or not it has been factory prime painted.
- .2 In "occupied" areas of building touch up any damage to prime coat resulting from shipping or installation and leave ready for final decorative painting under Finishes, Division 9.

In "un-occupied" areas of the building such as mechanical equipment rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses, provide corrosion coatings and floor sealers in accordance with specification section 20 05 02 *Painting for Mechanical Services*.
- .3 In addition, apply prime and/or final paint coats to equipment and materials where specifically detailed in other Sections of these Divisions.

8.6 Provision for Future

- .1 Where space is indicated as reserved for future equipment or for future extension to building, leave such space clear and install piping, raceways and equipment so that connections can be made to future apparatus or building.
- .2 Identify provisions and service terminations for future on Record Drawings.

8.7 Maintenance of Bearings

- .1 Turn-over rotating equipment at least once a month from delivery to site until start-up.
- .2 Run-in sleeve type bearings in accordance with manufacturer's written recommendation. After "run-in", drain, flush out and refill with new charge of oil or grease.
- .3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation during building construction.

8.8 Pre-purchased Equipment; Damage and Ownership

- .1 At time of receipt of pre-purchased or pre-tendered equipment at the job site by the installing mechanical contractor, provide the services of the manufacturer/distributor/supplier's technical representative to:
 - .1 inspect the equipment prior to unloading,
 - .2 witness the unloading and advise the contractor on the appropriate method for handling the equipment in order to avoid damage during the unloading, moving and setting in place phase of the equipment, and
 - .3 report any damage to the Consultant.
- .2 In the event the equipment has been found to be damaged before unloading, it is to be returned immediately to the factory for repairs and/or replacement by the manufacturer/supplier.
- .3 In the event of damage occurring at any time during unloading and until the equipment is accepted by the Owner, the installing contractor is responsible for repairs and/or replacement of the damaged equipment to the satisfaction of the Owner.

9 OFFICE AND STORAGE; TOOLS

9.1 Office and Storage

- .1 Provide temporary office, washroom and lunchroom facilities, workshop, and tools and material storage space. Facilities may be site trailers or as otherwise approved by the General Contractor/Construction Manager.
- .2 Assume responsibility for security of these facilities.
- .3 Provide heat, light and telephone and Internet service
- .4 Owners cafeteria is off limits.

9.2 Tools, Temporary Equipment and Materials

- .1 Provide tools, equipment, scaffolding, extension cords, lamps and miscellaneous consumable materials, required to carry out the Work.

10 COORDINATION; INSTALLATION DRAWINGS

10.1 Coordination

- .1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, etc. and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 Lay out and coordinate Work to avoid conflict with work under other Divisions.
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.
- .4 When equipment provided under other Sections connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .6 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- .7 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.
- .9 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the work as an operating installation.

10.2 Field, Fabrication, and Installation Drawings

- .1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services, and to demonstrate coordination with the work of other trades;
 - .1 drawing scale: minimum 1:50 (1/4"=1'-0")
 - .2 use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings,
 - .3 layout equipment and services to provide access for repair and maintenance,
- .2 Circulate drawings to other trades involved in each area, and conduct coordination meetings with those trades.

11 ANCHORS AND INSERTS

- .1 Supply anchor bolts and locating templates for installation in advance of concrete pouring.

12 CUTTING, PATCHING AND REMEDIAL WORK

12.1 General

- .1 Assume responsibility for prompt installation of work in advance of concrete pouring, masonry, roofing, finishing trades and similar work. Should any cutting or repairing of either unfinished or finished work be required because such installation was not done, employ the particular trade whose work is involved to do such cutting and patching and pay for any resulting costs.
- .2 Neatly cut or drill holes required in existing building elements to accommodate building services including ductwork, piping, cable, raceways, bus duct or cable tray.
- .3 Arrange and pay for all cutting and patching as required for the Work. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. Employ original installer or expert in the finishing of material required to perform cutting or patching for weather-exposed, moisture-resistant elements or sight-exposed surfaces.

12.2 Structure Scanning and Cutting

- .1 Layout cutting of structural elements, such as floors slabs, walls, columns or beams and obtain approval before starting work. Conduct an initial electromagnetic scan of reinforcing rods and electrical conduit, and review with structural engineering Consultant.

Standard of Acceptance

- ° Hilti - fig. PS 300 Ferrosan

13 PROTECTION OF PERSONNEL, WORK, AND PROPERTY

13.1 Personnel Protection

- .1 Without limiting the Contractor's responsibilities regarding occupational health and safety requirements at the construction site, provide specific personnel protection as follows:
 - .1 protect exposed live equipment during construction for personnel safety,
 - .2 shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage,
 - .3 arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician,
 - .4 do not leave conduit, wires, cables, tools, equipment or materials in such a way that they constitute a hazard,
 - .5 provide toe guards around openings in the roof or floor to prevent materials or debris from dropping down to a lower level,
 - .6 remove loose equipment and tools from overhead areas before leaving each day,
 - .7 cut off bolts at floor level to eliminate a possible tripping hazard.

13.2 Protection During Construction

- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during the Work. Accept responsibility for any damage and make good without cost to the Owner.
- .3 Protect existing surfaces and items so that they are not damaged in any way whatsoever by the work of all trades. Take precautions as necessary to prevent damage to walls, floors, ceilings, windows,

doors, door frames, moldings, finishes, piping, ductwork, light fixtures, etc. Provide protection, hoarding, tarpaulins, dust sleeves etc., as required. Any damage caused because of lack of adequate protection to be made good at no cost to the Owner.

- .4 Take care when working above or around equipment that must remain in service.
- .5 Take care to eliminate dust in equipment areas.
- .6 Protect switchgear fronts from accidental breaker trips when working around or above them. Provide an extended shield constructed of 12 mm (½") fire retardant plywood a minimum of 450 mm (18") from board front to allow access to board.

13.3 Core Drilling

- .1 Wherever core drilling is required, provide temporary dust proof screens.
- .2 In areas where core drilling through a slab in an operating facility is necessary, clearly mark out the areas to be drilled on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Provide tarping of equipment supervised by the Owner.
- .3 During core drilling operations, station at least one person directly below the area of drilling with a large plastic container pressed to underside of slab to capture and hold core and water upon completion of operations.
- .4 Continuously use a wet/dry commercial quality vacuum at location of drilling operation to remove all excess water from the area.

13.4 Temporary Dust Proof Screens

- .1 Provide temporary dust proof screens where required to separate work areas from completed areas and/or existing areas, to prevent dust from settling on the Owner's plant and equipment.
- .2 Dust proof material to be neoprene coated nylon tarpaulin or other types of fabric.
- .3 Provide temporary framing as required.
- .4 Extend dust proof screens from floor to underside of ceiling, floor, or roof above. Lap sections of screen sheets 150 mm (6") minimum and tape joints.
- .5 Secure screen sheets at top, bottom and ends and tape perimeter.
- .6 Provide temporary doors and frames with weather seals to provide frequent access to the work zone. Other closure methods may be used where infrequent access or short term access (less than one week) only is required.
- .7 Co-operate with Owner in the erection of temporary dust proof screens.
- .8 Provide yellow-black warning tape along perimeter of the screen junction with the floor.
- .9 Remove screens when and as directed by Consultant.

13.5 Protection of Floors During Equipment Installation

- .1 Provide protection of floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
- .2 Install 19mm (¾") plywood over 6 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish, or when installing equipment or line materials overhead.
- .3 Repaint or re-tile any floors or walls damaged or scratched during construction.

13.6 Housekeeping

- .1 Maintain a high level of cleanliness.
- .2 Remove scrap and refuse from the work area daily.
- .3 Whenever possible, clean up immediately following completion of work.
- .4 Deposit oily and waste solvent rags in approved containers to minimize the fire hazard.
- .5 Sweep and damp mop daily.

14 WORK IN EXISTING BUILDING

14.1 General

- .1 Comply with Specification section of Division 01 for restrictions on working in existing occupied buildings and as follows.
- .2 During the tender period, the Contractor shall perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of as-built conditions to determine scope of renovation or demolition work required prior to submitting tender.
- .3 The Work includes changes to existing building and changes at junction of old and new construction. Route pipes, ducts, conduits and other services to avoid interference with existing installation.
- .4 Core drilling to be coordinated with Owner for specific times.
- .5 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services required for proper installation of new work, including as required for temporary removal and re-installation to suit new installation work.
- .6 Remove existing plumbing fixtures, lighting fixtures, piping, ductwork, wiring, and equipment to suit new construction. Cut back and cap drain, vent and water outlets, conduits and electrical outlets, not being used.
- .7 Unless noted otherwise removed materials and equipment become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .8 On completion of relocations, confirm relocated equipment are in proper working order.
- .9 Where Owner wishes to take over renovated areas ahead of project completion date and these areas are to be fed from new distribution systems, make temporary connections to existing services in these areas. Reconnect to permanent services, at later date, when new distribution systems are available.

14.2 Continuity of Services

- .1 Keep existing buildings in operation with minimum length of shutdown periods.

- .2 Make connections to existing systems at approved times.
- .3 Obtain written approval recording times when connections can be made.
- .4 Arrange work so that physical access to existing buildings is not unduly interrupted.
- .5 Be responsible for and make good any damages caused to existing systems when making connections.
- .6 Provide premium time labour to tie-in to services at night or on weekends.
- .7 For piping systems, make connections to existing piping by draining down the existing piping system. Use of hot-tapping or freezing of piping is only permitted where approved by the Owner and a specification section for such work has been included in the project specifications.
- .8 Provide temporary services to drain down existing piping systems which convey liquids or steam condensate, including provision of temporary hoses, etc., and provide services to perform the drain down of these systems, except where the Owner elects to perform such drain-downs.
- .9 For piping systems conveying liquids, after completion of new work to existing piping systems, refill the existing and new piping systems including provision of cleaning of new piping and addition of chemical treatments, as applicable, in accordance with the requirements of other sections of Division 20. Include for addition of replenishing chemical treatment for existing piping systems in accordance with the Owner's existing chemical treatment program, or in the absence of such, in accordance with the chemical water treatment requirements specified in other Sections of Division 20.

15 MOVING AND SETTING IN PLACE OF OWNER-SUPPLIED PRODUCTS

15.1 General

- .1 The requirements of this Part applies to;
 - .1 Division 20 equipment that has been directly purchased by the Owner, and
 - .2 other Owner-supplied products or equipment (i.e. process equipment) that has building services requirements.

15.2 Owner-Supplied Products (Supplied by Owner Equipment – “SBO”)

- .1 Items marked SBO on drawings are to be;
 - .1 purchased by the Owner,
 - .2 received, checked, and stored by the Contractor, and
 - .3 subsequently unpacked, uncrated, assembled and located in its final location by the Contractor, and installed in accordance with the manufacturer instructions,
 - .4 participate in the start-up and testing of the equipment and placing into service.
- .2 Provide mechanical and electrical services to SBO equipment in accordance with the SBO equipment manufacturer's instructions and as otherwise shown.

15.3 Existing Owners Equipment to be Relocated (E.R. or Ex. Rel.)

- .1 Applies to owners existing equipment which has mechanical and electrical services, and marked on the drawings as E.R. Ex.Rel. or otherwise so identified.
- .2 Items so marked on drawings are to be moved from their present location and reinstalled by the Contractor.
- .3 Disconnect and reconnect mechanical and electrical services to accommodate this equipment relocation.

16 TEMPORARY HEATING

- .1 Temporary heating required while building is under construction will be provided under Division 01.
- .2 Permanent heating system may be used for temporary heating, when this equipment is installed in its permanent location and the building is closed-in and Contractor under Division 1 provides staff for operation and maintenance whenever permanent heating system is being used for temporary heating.
- .3 Hot water boilers may not be used unless heating units, radiation, pumps and piping are complete, the piping system has been pressure tested, cleaned, and final chemical water treatment is in operation.
- .4 Permanent heating equipment used for temporary heating to be thoroughly cleaned and put in first class operating condition and appearance at completion of the Work, as approved by the Owner.

17 FINAL CLEANING AND ADJUSTMENTS

17.1 Final Cleaning

- .1 Conduct final cleaning in accordance with Division 01 74 00 requirements and as specified herein.
- .2 Perform final cleaning after construction activities that create dust have been completed.
- .3 Thoroughly clean exterior surface of exposed piping, and vacuum external surfaces of exposed ducts and interior surfaces of air handling units. Clean strainers in piping systems and install clean filters in air handling systems immediately prior to handover of the building to the Owner.
- .4 HEPA vacuum the top and interiors of motor controllers, VFDs, control panels, and control cabinets followed by a thorough HEPA vacuuming of the service room floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
- .5 Remove tools and waste materials on completion of work and leave work in clean and perfect condition.

17.2 Final Adjustments

- .1 Calibrate components and controls and check function and sequencing of systems under operating conditions.
- .2 Supply lubricating oils and greases for proper operation of equipment and systems until work has been accepted.

18 RECORD DRAWINGS

18.1 Record Drawings

- .1 Maintain record drawings in accordance with Section 01 78 00 during the course of the Work and as follows.
- .2 A set of design drawings in AutoCad, or PDF format (as determined by the Consultant) will be provided by the Consultant. Record changes in actual installation as the Work progresses by the following method:
 - .1 make sets of white prints for each phase of Work and mark-up the print drawings, or
 - .2 revise the AutoCad or Revit file directly, and identify all changes made.
- .3 Mark-up these record drawings to provide dimensioned locations of drains, pipes, ductwork, conduit, manholes, foundations and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.
- .4 Retain on-site the survey information from excavation and backfill of site services, and after approval, transfer this information to the record documents.

- .5 Retain these drawings and make available to Consultant for periodic review.
- .6 At 50%, 75% and 90% project completion, scan marked-up drawings to PDF format and submit copy to the Consultant, or to the project on-line document management service if one is used.

18.2 As-Built Drawings

- .1 Prior to testing, balancing and adjusting, transfer site record drawing information to a copy of the computer aided drafting/design program ("CAD") files, in the same software format used for the Consultants design drawings, to record final as-built condition.
- .2 Obtain a current set of CAD files from the Consultant. The Consultant's CAD files may not reflect all or any construction changes.
- .3 Drawings are to remain set to and follow Consultants CAD Standards - do not alter drawing scales, reference files, colours, layers or text styles,
- .4 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions, and place these annotations on a separate and easily identified drawing layer.
- .5 Show on mechanical as-built drawings final location of piping, ductwork, switches, starters, Motor Control Centres, thermostats, and equipment.
- .6 Show on site services as-built drawings survey information provided by an accredited land surveying service.
- .7 Identify each drawing in lower right hand corner in letters at least 12 mm (½ in) high with a note as follows:

<p>AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed (Signature of Contractor) (Date).</p>
--

- .8 The site services drawings are to include the signature and stamp of the accredited surveyor adjacent to the note.
- .9 Submit one (1) set of white prints of the draft as-built CAD files for Consultant's review.
- .10 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return CAD files modified to "As Built" condition to Consultants electronically by removable mass storage device or by electronic file transfer as designed by the Consultant.
- .11 Submit three (3) sets of white prints and one (1) electronic copy of CAD files with Operating and Maintenance Manuals to the Owner.

19 OPERATING AND MAINTENANCE INSTRUCTIONS

19.1 Operating and Maintenance Manuals

- .1 Provide operating and maintenance manuals in accordance with Section 01 78 00 *Closeout Submittals* and as follows.
- .2 Provide operation and maintenance data bound in vinyl covered, hard back, three-ring covers, nominally 50 mm (2 in) thick, suitable for paper size of 210 mm x 300 mm (8½ in x 11 in);
 - .1 organize material in volumes, generally grouped by Trade section;
 - (a) Table of Contents,
 - (b) General Information,

- (c) Sub-contractors (list),
 - (d) Site services,
 - (e) Fire Protection,
 - (f) Plumbing,
 - (g) Heating and Cooling Plant and Distribution,
 - (h) Air Handling Equipment and Distribution,
 - (i) Building automation, Controls and Instrumentation,
 - (j) Testing Reports,
 - (k) As-Built Drawings,
 - (l) Warranties.
- .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear;
- (a) Project Name,
 - (b) Project Number,
 - (c) Date,
 - (d) Trade Section,
 - (e) List of Contents.
- .3 Provide three hard-copies to Owner.
- .3 In addition, provide PDF files for each document, produced from original direct-to-digital file creations;
- .1 organize documents into separate PDF files for each Trade Section identified above, and apply PDF Bookmarks to create a Table of Contents for each file.
- .4 Operating data to include;
- .1 control schematics for each system,
 - .2 description of each system and associated control elements,
 - .3 control operating sequences at various load conditions, reset schedules and anticipated seasonal variances,
 - .4 operating instructions for each system and each component,
 - .5 description of actions to be taken in event of equipment failure,
 - .6 valve schedules and flow diagrams,
 - .7 service piping identification charts.
- .5 Maintenance data to include;
- .1 manufacturer's literature covering servicing, maintenance, operating and trouble-shooting instructions for each item of equipment,
 - .2 fault locating guide,
 - .3 manufacturer's parts list,
 - .4 reviewed shop drawings,
 - .5 equipment manufacturer's performance sheets,
 - .6 equipment performance verification test results,
 - .7 voltage and ampere rating for each item of electrical equipment,
 - .8 spare parts list and an itemized cost,

- .9 name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.
- .6 Approval procedure;
 - .1 submit one set of first draft of Operating and Maintenance Manuals for approval at least one month prior to planned substantial performance date,
 - .2 make corrections and resubmit for a final review,
 - .3 review contents of Operating and Maintenance Manuals with Owner's operating staff or representative to ensure thorough understanding of each item of equipment and its operation.
 - .4 hand-over two (2) hard-copies and one (1) PDF copy on removable storage device of the Operating and Maintenance Manuals to the Owner's operating staff and obtain written confirmation of delivery. Provide a copy of the delivery record to the Consultant.

19.2 Operating and Maintenance Training

- .1 Provide operating and maintenance training in accordance with Section 01 79 00 *Demonstration and Training* and as follows.
- .2 Provide training to Owners operations staff to thoroughly explain operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other Sections in these Divisions. Include classroom instruction and hands-on instruction, delivered by competent instructors.
- .3 Develop the proposed training plan, and submit an outline of the training program for review, adjustment and approval by the Owner.
- .4 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, utilizing the services of the manufacturers' representative as required.
- .5 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each training topic, separated by approximately one week each. Develop the proposed training plan and obtain approval from the Owner before commencing training.
- .6 All training to be scheduled and provided between the hours of 7 am to 5 pm, Monday to Friday. Where training is required to be performed outside of these hours due to availability of Owners operations personnel, if the trainers are paid for overtime outside of these hours, the overtime portion only is eligible to be paid by the Owner as an extra cost.
- .7 Complete the training as close to Substantial Performance as possible, so that the operations staff are prepared to operate the systems after Substantial Performance is certified.
- .8 Organize each training sessions as follows:
 - .1 Fire Protection - Division 21
 - .2 Plumbing – Division 22
 - .3 HVAC – Division 23
 - .4 Building Management System – Division 25
- .9 Keep records of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.
- .10 For each training session, include the following topics;
 - .1 general purpose of system (design intent),

- .2 use of O&M manuals,
- .3 review of control drawings and schematics,
- .4 start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control set-up and programming troubleshooting, and alarms,
- .5 interaction with other systems,
- .6 adjustments and optimizing methods for energy conservation,
- .7 health and safety issues,
- .8 special maintenance and replacement sources,
- .9 occupancy interaction issues, and
- .10 system response to different operating conditions.
- .11 Develop and provide training material, including printed documents and electronic presentation aids (e.g. MS PowerPoint) for each session. Submit three (3) copies of materials in both hardcopy and PDF format, in accordance with article on Operating and Maintenance Manuals.
- .12 Sessions may be video recorded by the Owner as an aid to ongoing training of Owners staff.

20 CARE, OPERATION AND START-UP

- .1 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of the installation, check, adjust, balance and calibrate components and equipment as specified in the specification sections of Division 20.
- .2 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with every aspect of the operation, care and maintenance thereof.
- .3 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of the installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.

21 TESTING

21.1 General

- .1 The following describes the general requirements for testing of mechanical systems; refer to additional testing requirements in applicable sections of Division 20 of the Work.
- .2 Conduct tests during progress of Work and at its completion to verify equipment and systems meet the contract documents. Submit details of test methods in writing and obtain approval before commencing work.
- .3 Supply test equipment, apparatus, gauges, meters and data recorders, together with skilled personnel to perform tests and log results.
- .4 Submit written notice 24 hours in advance of each test series, setting out the time, place and nature of the tests, to the Inspection Authority and personnel witnessing tests.
- .5 The Owner reserves the right to witness any test; any such witnessing activity shall not be construed as acceptance of the system or equipment by the Owner.
- .6 Conduct tests before application of external insulation and before any portion of pipes, ducts or equipment is concealed.

- .7 Do not subject expansion joints, flexible pipe connections, meters, control valves, convertors, and fixtures, to test pressures greater than the stated working pressure of equipment. Isolate or remove equipment or devices during tests when prescribed test pressure is greater than working pressure of any piece of equipment or device.
- .8 Should section of pipe, duct, or electrical cable fail under test, replace faulty piping, duct, or cable with new fittings, pipe, duct or cable and then retest. Do not repair threaded pipe joints by caulking nor welded joints by peening. Repeat tests until results are satisfactory.
- .9 Where it is necessary to test portions of piping, ductwork or electrical cable system before system is complete, overlap successive tests so that no joint or section of duct or pipe is missed in testing.
- .10 Upon completion of work and testing of same, submit logs to demonstrate that tests have been carried out satisfactorily. Repeat any tests if requested.

21.2 Testing of Integrated Life Safety and Fire Protections Systems

- .1 Conduct testing of integrated life safety and fire protection systems in accordance with specification Section 20 08 11 *Testing of Integrated Electrical Life Safety and Fire Protection Systems*.

21.3 Testing - Potable Water Piping

- .1 Except where otherwise specified in other sections of Division 22, test potable water systems with water or air as required by the plumbing code in effect at the location of the Work.
- .2 For water service pipes 100 mm (4") and larger, disinfect the pipe with chlorine ("hyper-chlorinate") from the street valve to the first shut-off valve inside the building. At completion of disinfection, take water samples just before the utility meter and pay for the samples to be tested by an accredited testing laboratory. Test the water samples for contaminants and to measure the residual chlorine concentration and provide test certificate confirming water contaminates are below the threshold values proscribed by applicable legislation.
- .3 Where stainless steel piping is used in the domestic water system, between the entry point in the building and the utility water meter, after taking the water sample for laboratory testing, immediately drain down the incoming service piping up to the utility meter and then flush with clean city water until a site test of the drain water shows a residual chlorine level not greater than the incoming city water supply.
- .4 Where stainless steel piping is used in potable water piping inside the building (i.e. downstream of the utility meter), do not allow any hyper-chlorinated water used for disinfection of piping to come into contact with the stainless steel piping.

21.4 Testing - Other Piping

- .1 Except where otherwise specified in other sections of Divisions 21, 22 or 23, hydraulically pressure test other water piping systems at 1½ times system design pressure (relief valve setting) or 1000 kPa (150 psi), whichever is greater, for 10 minutes then reduce the test pressure and hold for 24 hours. Pressure must remain essentially constant throughout test period without pumping. Make allowance for correction of pressure readings for variations in ambient temperature between start and finish of test.
 - .1 Alternatively, hold the pressure at the design pressure and testing all joints with a soap test.
- .2 Test natural gas system in accordance with CSA B149.1 *Natural Gas and Propane Piping Code*.
- .3 Test fuel oil systems in accordance with CSA B139 *Installation Code for Oil Burning Equipment*.
- .4 Test drainage, waste and vent piping for tightness and grade as required by the plumbing code in effect at the location of the Work.
- .5 Test special service piping as detailed in other sections of Divisions 21, 22 and 23.

21.5 Testing - Ventilation

- .1 Pressure test ductwork in accordance with section 23 31 13 *Ductwork*, or other applicable sections of Division 23.

21.6 Testing - Electrical

- .1 Make tests of equipment and wiring. Test wiring systems in accordance with section 20 05 12 *Wiring Requirements for Mechanical*.
- .2 Replace defective equipment and wiring with new material.

22 TEMPORARY AND TRIAL USAGE

- .1 Temporary and trial usage by Owner of any mechanical or electrical device, machinery, apparatus, equipment or any other work or materials before final completion and written acceptance is not to be construed as evidence of acceptance by Owner.
- .2 Owner to have privilege of such temporary and trial usage, as soon as that said work is claimed to be completed and in accordance with Contract Documents, for such reasonable length of time as is sufficient for making complete and thorough test of same.
- .3 No claims will be considered for damage to or failure of any parts of such work so used which may be discovered during temporary and trial usage, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.
- .4 Defects in workmanship and materials identified during temporary and trial usage are to be rectified under warranty.

23 SPECIAL TOOLS AND SPARE PARTS

23.1 Spare Parts

- .1 Prior to application for Substantial Performance, furnish spare parts as follows;
 - .1 one set of filter cartridges for each filter or filter bank installed.
- .2 Maintain an inventory record and delivery receipt record of spare parts delivered to the Owner, and include them in the Operating and Maintenance manuals.

24 CONSULTANT REVIEWS

24.1 General

- .1 Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and as required by the local authority have jurisdiction. It is the Contractor's responsibility to ensure that the Work is complete and constructed in accordance with the design documents.

24.2 Site Reviews

- .1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances, before the work is completed, readily noticeable deficiencies may be recorded by the Consultant where the deficient item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work, specifically in identification and rectification of deficiencies or incomplete Work.

- .2 Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless otherwise shown.

24.3 Milestone Reviews

- .1 Specific milestone reviews may be conducted at key stages by the Consultant, including;
 - .1 before backfilling of buried drainage,
 - .2 before closing of shafts,
 - .3 before closing of ceilings,
 - .4 before closing of walls,
 - .5 equipment demonstration,
 - .6 Substantial Performance deficiency review,
 - .7 Total Performance deficiency review.
- .2 Coordinate with the Consultant the type and quantity of milestone reviews required by the Consultant and incorporate these requirements in the construction schedule.
- .3 Notify the Consultant in writing seven (7) calendar days in advance of work to be concealed to arrange a site review prior to the Work being concealed where required by the Consultant. Any noted deficiencies are to be corrected before being concealed. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

24.4 Partial Occupancy Reviews

- .1 Where the Work is planned to include occupancy by the Owner of a part of the Work but not the entire Work ("partial occupancy"), the procedures specified for Substantial Performance Review will apply to the portion of the Work being considered for partial occupancy.

24.5 Substantial Performance Review

- .1 At the time of applying for project Substantial Performance, submit to Consultant a comprehensive list of items to be completed or corrected.

24.6 Final Review

- .1 At project completion submit written request for final review of mechanical and electrical systems. Refer to section 20 08 19 *Project Close-Out*.
- .2 Include with the request a written certification that:
 - .1 reported deficiencies have been completed,
 - .2 systems have been balanced and tested and are ready for operation,
 - .3 completed maintenance and operating data have been submitted and approved,
 - .4 equipment/line material tags are in place and equipment identification is completed,
 - .5 cleaning is finished in every respect,
 - .6 all mechanical equipment surfaces have been touched up with matching paint, or re-finished as required,
 - .7 spare parts and replacement parts specified have been provided and receipt acknowledged,
 - .8 As-built and Record drawings are completed and approved,

- .9 Owner's operating personnel have been instructed in operation and maintenance of systems,
- .10 fire protection verification is 100% completed and Verification Certificates have been submitted and accepted.

25 CONTRACTOR INSPECTIONS

25.1 General

- .1 The Division 20 contractor shall assign one person responsible for ensuring that Work from all mechanical trades is complete prior to;
 - .1 closing in wall, ceilings or burying of services,
 - .2 partial-occupancy reviews, and
 - .3 substantial performance reviews.
- .2 In conjunction with the Contractor's Mechanical and Electrical sub-contractors, the Contractor shall walk the site and thoroughly inspect that the work is complete, in good workmanship and installed according to the contract documents and derived documents therefrom. The Contractor shall then submit a report attesting to the completed state of the Work (the "Statement of Completion" report, as detailed later in this part).
- .3 In the case of Contractor inspections for partial-occupancy or substantial performance, submit the Statement of Completion report at least 24 hours prior to the scheduled review by the Consultant.

25.2 Concealed Space Digital Image Records

- .1 Where services are to be concealed behind walls, ceilings, or buried, the Contractor shall make a digital photo or digitally scanned record of the Work, and assemble these digital records in a logical file structure, organized by floor or department, with each record filename including the room number, so as to form a comprehensive documentation of the completed services.
- .2 The digital files and folders are to be turned over to the Consultant for review prior to the Consultant's reviews for partial- occupancy or substantial performance.
- .3 As part of the request for substantial performance of the Work, submit two (2) copies of the digital record on separate removable storage devices to the Owner for their use. These records are in addition to other construction records including as-built documentation.

25.3 Contractor Inspections for Partial Occupancy and Substantial Performance

- .1 In preparation for the Consultants general review for partial-occupancy and/or substantial performance of the Work, the Contractor shall perform a comprehensive inspection of the Work to ensure that their contractual obligations are met before requesting a Consultant's review of the Work. In performing this inspection, the Contractor shall create a Statement of Completion report which is to include;
 - .1 date and time of the Contractor's inspection, signed by the person who conducted the inspection,
 - .2 names of the mechanical contractor's personnel who participated in the inspection,
 - .3 confirmation that previously noted deficiencies have been completed,
 - .4 confirmation that the work is 100% complete, tested, balanced and free of deficiencies, or include a list of outstanding deficiencies and incomplete Work with;
 - (a) a reason why the Work has not been completed (i.e. another trade has to complete their work)
 - (b) a plan of action to complete the Work, and
 - (c) a commitment date for completion of the Work including rectification of all deficiencies.

- .2 The format of the Statement of Completion shall be approved by the Consultant.
- .3 The Consultant shall review and sign-off the Statement of Completion Report and return a copy to the Contractor. The Contractor shall retain on-site a log of all signed off Statement of Completion reports.
- .4 If a required Statement of Completion report is not received, the Consultant reserves the right to withhold conducting a review for partial-occupancy or substantial performance.
- .5 After receipt of the Contractor's Statement of Completion report, if upon entering an area of the work covered by the Statement of Completion report the Consultant determines, in its sole opinion, that the applicable Work is not ready for review, the Consultant may elect to cancel the review of the Work or the affected portion of the Work, and shall assume no responsibility for any damages or losses as a result of cancellation of the review. The Contractor shall remedy the incomplete work and request another review with 72 hours prior written notice, and shall resubmit the revised Statement of Completion at least 24 hours prior to the new review.

26 CORRECTION AFTER COMPLETION

- .1 At completion, submit a written warranty undertaking to remedy defects in work for a period of one year from date of substantial performance of the Work. This warranty is not to supplant other warranties of longer period called for on certain equipment or materials.
- .2 Warranties are to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation of the corrected Work.
- .3 Submit similar warranties for one year from date of acceptance for any part of work accepted by Owner, before completion of the whole Work.

27 ATTACHMENTS

27.1 Schedule of Values Form

- .1 Attached sample of the Schedule of Values form layout.

27.2 Shop Drawing Submittal Form

- .1 Attached sample of shop drawings submittal form.

SCHEDULE OF VALUES

Project Name: <<name of project>>
Owner Name: <<owner name>>
Contractor Name: <<name of trade contractor: mechanical, electrical, etc>>
Division(s) of the Work: <<i.e. 20, 21, 22...>>
For the billing period ending: dd-mmm-yyy

This sheet is an example of a required schedule of values to be developed by the Contractor, to be submitted with each progress payment request.
Specific level of detail for each work element to be approved by the Consultant.

Item	Base Contract Element	Contract Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
1.1	<<work element>>	1,000,000.00	65.9%	400,000.00	40.0%	225,000.00	22.5%	175,000.00	17.5%	600,000.00	60.0%
1.2	<<work element>>	250,000.00	16.5%	30,000.00	12.0%	5,000.00	2.0%	25,000.00	10.0%	220,000.00	88.0%
1.3	<<work element>>	125,000.00	8.2%	50,000.00	40.0%	22,000.00	17.6%	28,000.00	22.4%	75,000.00	60.0%
X.X	Itemized Price No. 1	25,000.00	1.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%	25,000.00	100.0%
X.X	Separate Price No. 1	12,500.00	0.8%	5,000.00	40.0%	0.00	0.0%	5,000.00	40.0%	7,500.00	60.0%
CAA.1	Cash Allowance Disbursements Summary	75,000.00	4.9%	34,000.00	0.0%	8,000.00	0.0%	26,000.00	0.0%	41,000.00	0.0%
X.X	Coordination drawings	15,000.00	1.0%								
X.X	As-built documents and operating manuals	15,000.00	1.0%								
Original Contract Values		1,517,500.00	100.0%	519,000.00	34.2%	260,000.00	17.1%	259,000.00	17.1%	968,500.00	63.8%
CO.1	Approved Changes Summary	13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%
Total Current Contract Values		1,530,900.00		524,200.00	34.2%	262,000.00	17.1%	262,200.00	17.1%	976,700.00	63.8%

Reference	Cash Allowance Disbursement	CA Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CAA_1	<<description of cash allowance>>	20,000.00		20,000.00	100.0%	8,000.00	40.0%	12,000.00	60.0%	0.00	0.0%
CAA_2	<<description of cash allowance>>	55,000.00		14,000.00	25.5%	-	0.0%	14,000.00	25.5%	41,000.00	74.5%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		75,000.00		34,000.00	45.3%	8,000.00	10.7%	26,000.00	34.7%	41,000.00	54.7%

Reference	Approved Changes	Change Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CO_01	<<description of change of work>>	5,800.00		-	0.0%	-	0.0%	0.00	0.0%	5,800.00	100.0%
CD-01	<<description of change of work>>	7,600.00		5,200.00	68.4%	2,000.00	26.3%	3,200.00	42.1%	2,400.00	31.6%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%

Reference	Unquoted/Unapproved Changes	Status	Quotation	
			\$	%
CCN-01	<<description of change of work>>	Waiting for approval	12,000.00	
CCN-02	<<description of change of work>>	Unquoted		
Total			12,000.00	



Toronto Montreal Vancouver Dallas Chicago

SHOP DRAWING SUBMITTAL

***Include this cover page with each shop drawing submission.
Submissions without this form will be returned without review.
Submit one submittal form per shop drawing; do not group under one submittal sheet***

Client/Architect:

Project Name:

HHA Project No:

Contractor to complete the following for each submission.

Date:

Contractor Name: Ref. No:

Manufacturer Name:

Product Type/Description:

Specification section number:

Contractor Trade Category:

- | | | | |
|--|-------------------------------------|--|---|
| <input type="checkbox"/> Architectural | <input type="checkbox"/> Structural | <input type="checkbox"/> Conveying Equipment | <input type="checkbox"/> User Equipment |
| <input type="checkbox"/> Mechanical | <input type="checkbox"/> Electrical | <input type="checkbox"/> Telecommunications | <input type="checkbox"/> Civil |
| <input type="checkbox"/> Other | | | |

If this is a resubmission, check here: ☐

Previous submission HHA reference no.:

hhangus.com



END OF SECTION

QUALIFICATIONS AND AUTHORITIES - ONTARIO

20 01 02

1 GENERAL

1.1 Scope

- .1 This specification section:
 - .1 describes the qualification requirements for tradesmen in the province of Ontario;
 - .2 defines the applicable authorities having jurisdiction related to construction in Ontario; and
 - .3 describes the responsibilities of the contractor and/or Owner for registration and inspection of systems and application for construction or installation permits.

1.2 Definitions

- .1 **TSSA:** Technical Standards and Safety Authority
- .2 **ESA:** Electrical Safety Authority

2 QUALIFICATIONS

2.1 Trades Qualification and Apprenticeship

- .1 Tradesmen to hold a certificate of competency for the following applicable trades:
 - .1 Construction Millwright, O.Reg. 1048
 - .2 Electrician, O.Reg. 1051
 - .3 Plumber, O.Reg. 1073
 - .4 Refrigeration and air-conditioning mechanic, O.Reg. 75/05
 - .5 Sheet metal worker, O.Reg. 1077
 - .6 Sprinkler and fire protection installer, O.Reg. 1078
 - .7 Steamfitter, O.Reg. 1079

2.2 Work-Specific Qualification Licenses

- .1 Fabricators and installers of pressure piping and equipment which are subject to O.Reg. 220/01 *Boilers and Pressure Vessels* regulation shall hold the required license for performing such work, unless otherwise exempt by the regulation.
- .2 Contractors performing work on liquid or gaseous fuel piping systems and related equipment shall hold certificates of authorization made under O.Reg. 215/01 *Fuel Industry Certificates* to perform work within the scope of the following regulations:
 - .1 Gaseous Fuels, O.Reg. 212/01
 - .2 Propane Storage and Handling, O.Reg. 211/01
 - .3 Fuel Oil, O.Reg. 213/01
 - .4 Compressed Natural Gas, O.Reg. 214/01

3 AUTHOURITIES

3.1 Authorities having Jurisdiction

- .1 When referenced in specification sections in Division 20 to 25, the authority-having-jurisdiction ("AHJ") over regulated portions of the work are identified in the following table.

Work Element	Authority	AHJ Abbreviation
Fire Protection	Municipal Building Department or Fire Department	None
Plumbing	Municipal Building Department	None
HVAC	Municipal Building Department	None
Flammable and Combustible Liquids	Fire Department	None
Liquid fuels (for vehicle refueling)	TSSA	TSSA (FS)
Heating Oil and Diesel Fuel	TSSA	TSSA (FS)
Propane	TSSA	TSSA (FS)
Pressure Piping	TSSA	TSSA (BPV)
Refrigeration	TSSA	TSSA (BPV)
Licensed Plant Operators	TSSA	TSSA (OE)
Electrical	ESA	ESA

4 PERMITS, REGISTRATION AND INSPECTION

4.1 Building Code Permits

- .1 Application for Building Permit including plumbing and HVAC has been made by the Owner. Arrange and coordinate for municipal inspections as required under the Ontario Building Code.
- .2 Application for Building Permit has been made by the Owner. Submit and pay for separate plumbing and HVAC permits and arrange and coordinate for municipal inspections required under the Ontario Building Code

4.2 Other Work Permits, Registration and Inspection

- .1 Arrange, provide documentation, and pay for permits, registration, and inspection of the following work elements:
- .1 Boilers, pressure vessel and pressure piping,
 - .2 Buried liquid fuel tanks and underground piping,
 - .3 Electrical work performed under Division 20 to 25, and
 - .4 Where described elsewhere in Division 20 to 25.

- .2 Arrange, provide documentation, and pay for variance approvals and field inspections where specified elsewhere in Division 20 to 25.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

DEFINITIONS AND ABBREVIATIONS - MECHANICAL 20 01 13

1 GENERAL

1.1 Scope

- .1 This specification provides definitions and abbreviations of terms which may apply to one or more specification sections under Division 20, 21, 22, 23 and 25.
- .2 Additional definitions and/or abbreviations may also be included in other specification sections where they apply only to one specification section.

1.2 Definitions

- .1 General definitions:

Authourity having Jurisdiction ("AHJ"): the designated government body or regulatory agency responsible for enforcement of applicable statute.

Bronze: a copper alloy with a minimum copper content of 84%.

Building Automation System ("BAS"): the building control systems as specified in Division 25.

Class XXX: a numerical pressure-temperature designation "XXX" in accordance with ANSI/ASME B16 series of standards.

Canadian Registration Number ("CRN"): as defined in accordance with CSA B51.

Certificate of competency: a license, certificate or other document which attests to the qualifications of a construction tradesperson and which is recognized and/or required under prevailing provincial, territorial or federal statutes in the location of the project as an authorization to perform such work.

Cold Working Pressure ("CWP"): the maximum non-shock cold working pressure at temperatures as stated in a MSS valve standard.

Design Criteria: criteria that states the requiree performance of equipment or a system, and is also the minimum design basis for equipment, systems and contractor's design responsibilities.

Design Pressure: (in reference to a pressure piping system) - the maximum allowable internal pressure in a piping system at the indicated coincident Design Temperature that the piping system may be subjected under normal operating conditions and is the basis for determining the piping system hydrostatic or pneumatic test pressure requirements.

Design Temperature: (in reference to a pressure piping system) – the maximum allowable in-service temperature of the piping system.

Double Regulating Valve ("DRV"): a calibrated manual flow balancing valves with pressure test ports (also referred to as circuit balancing valve),

Dezincification Resistant ("DZR"): a brass copper alloy which by means of its alloy and method of manufacture is certified as being resistant to the process of dezincification.

Flow Limiting Regulating Valve ("FLRV"): an automatic calibrated flow control device which limits the maximum flow to a branch piping network.

Minimum Component Pressure Rating (“MCPR”): the minimum pressure at the indicated coincident temperature at which the component must be capable of withstanding, remain functional and not exceed its maximum allowable stress in accordance with its referenced standard.

National Pipe Taper (“NPT”): a pipe thread in accordance with ANSI/ASME B1.21.1

Operating Pressure: the estimated maximum expected internal operating pressure of a fluid in a pipe or equipment for the purpose of establishing a piping system Design Pressure; actual in-service gauge pressures may be lower. The operating pressure may be specified as a single value, or it may vary by location in the system. “Working pressure” has the same meaning.

Operating Temperature: the estimated maximum normal temperature of the fluid in a piping system

Potable water: has the same meaning as defined in the applicable plumbing code or building code in the jurisdiction of the project. “Domestic water” has the same meaning.

Steam Working Pressure (“SWP”): the maximum steam pressure at the indicated maximum steam temperature or it is the saturated steam pressure if a coincident temperature is not specified.

Service rooms: means a room provided in a building to contain equipment associated with building services, and which includes but is not limited to: boiler rooms; furnace rooms; incinerator rooms; garbage handling rooms; rooms to accommodate HVAC appliances, pumps, compressors and other related equipment; rooms containing electrical distribution equipment; and rooms containing telecommunications and data equipment.

Service space: means space provided in a building to facilitate or conceal the installation of building service facilities such as chutes, ducts, pipes, shafts or wires.

1.3 Abbreviations

AMCA	Air Movement and Control Association International
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
CSA	Canadian Standards Association
FM	Factory Mutual Approvals
MCAA	Mechanical Contractors Association of America
MCAC	Mechanical Contractors Association of Canada
MSS	Manufacturers Standardization Society
NECA	National Electrical Contractors Association

NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	NSF International (formerly National Sanitary Foundation)
SMACNA	Sheetmetal and Air Conditioning Contractors' National Association
UL	Underwriters Laboratory (USA)
ULC	Underwriters Laboratory Canada

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

BASIC MATERIALS AND METHODS

20 05 01

1 GENERAL

1.1 Scope

- .1 Articles that are of a general nature, and applicable to each Section of Division 20 to 25.

2 ACCESSIBILITY FOR BUILDING CONTROL DEVICES

- .1 Mount control devices, intended to be adjusted or to otherwise be operated by the occupant for the operation of building services or safety devices, as follows:
 - .1 room environmental controls, including thermostats/adjustable room temperature sensors: at 1200 (47 in) above the finished floor,
 - .2 all other controls: between 900 and 1100 mm (36 in. and 43 in.) above the finished floor.
 - .3 be positioned to have a clear space in front of and centered on the control device, of 810 x 375 mm (32 x 15 in).
 - .4 be operable using a closed fist and with a force not exceeding 22.2 N (5 lbf).
- .2 The above requirements do not apply to control devices that are solely located and used by the building operations staff.

3 ACCESS DOORS

3.1 General

- .1 Provide access doors to be installed at locations where equipment requiring inspection, service, maintenance or adjustment is "built-in" to work of other trades.

Standard of Acceptance

- Williams Brothers – fig. GP
- Elmdor/Acorn - fig. DW
- Mifab - fig. UA

3.2 Applicable Product Standards:

- .1 CAN/ULC-S104 Standard Method for Fire Testing of Door Assemblies

3.3 Construction:

- .1 Standard access door:
 - .1 1.6 mm (16 ga) carbon steel door and door-frame with white satin coat prime coat finish, with door edges turned back to frame for rigidity,
 - .2 flush mounted with 180° opening door, round safety corners, concealed hinges, plaster lock and anchor straps,
 - .3 latch: screw driver operated,
 - .4 access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.
 - .5 size:
 - (a) 600 mm x 600 mm (24 in x 24 in) for personnel entry,

(b) 300 mm x 450 mm (12 in x 18 in) for hand entry,

.2 Variations:

.1 stainless steel variant:

(a) Type 304 stainless steel with No. 4 brush satin finish.

.2 waterproof variant:

(a) Type 304 stainless steel with No. 4 brush satin finish, with neoprene gasketed door.

.3 security access variant:

(a) keyed cylinder, with all cylinders keyed alike,

.4 fire rated variant:

(a) where access door is located in a horizontal or vertical fire separation that has a fire resistance rating of 2 hours or less,

(b) insulated door with 50 mm (2 in) fire retardant mineral wool insulation, and 0.95 mm (20 ga.) back liner,

(c) heavy duty spring for self-closing door action,

(d) rated for installation in masonry walls and fire rated shaft wall construction, or fire rated ceiling construction as applicable to the installation,

(e) listed to CAN/ULC-S104 for minimum 1.5 hour closure ratings.

.5 Submit shop drawings showing access door size, type and location.

3.4 Installation:

.1 Access doors are required at;

.1 expansion joints,

.2 dampers,

.3 fire dampers,

.4 air valves,

.5 air terminal units,

.6 isolation and control valves ,

.7 pressure reducing valves,

.8 heating or cooling coils,

.9 control wiring junction boxes.

.2 Supply access doors and make arrangements and pay for installation by Division in whose work they occur.

.3 Supply access doors with the required variations in accordance with the following table:

Space Type	Wall or Ceiling Finish	Variants		
		Stainless Steel	Water-proof	Key lock
Service rooms, Service corridors, Public spaces and corridors - more than 2.4 m (8 ft) above the floor, Private spaces, washrooms	Drywall	---	---	---
	Tile or other hard finished surfaces	Yes	---	---
Public spaces and corridors - 2.4 m (8 ft) or less above the floor, Mental health patient areas, Public washrooms	Drywall	---	---	Yes
	Tile or other Hard Surfaces	Yes	---	Yes
Shower rooms, bathtub rooms, Pools, saunas, Kitchens, laundries, Other damp, washdown or high humidity spaces	All	Yes	Yes	Yes

- .4 Provide fire rated variant in addition to the above table variants, as applicable to the wall or ceiling construction.
- .5 Size and locate access doors in applied tile, block or in glazed or unglazed structural tile to suit joint patterns.
- .6 Access doors are not required in removable ceilings. Provide coloured marking devices after completion of ceilings, at four corners of each panel below point requiring access. Colour code markers to show service or device above.
- .7 At time of instruction of owners operating staff, hand-over and obtain signed receipt for 4 sets of each type of key used for access doors with key-lock cylinders.

4 DIELECTRIC FITTINGS

- .1 Dielectric unions – NPS 2 and under:
 - .1 flat-face union design,
 - .2 tail-piece with NFPT ends with thermobaked epoxy coating, and Teflon shoulder gasket,
 - .3 Head-piece with integral O-ring, with threaded or sweat pipe ends.
 - .4 Brass union nut.
 - .5 pressure rating: Class 3000.
 - .6 dielectric coating resistance rating: minimum 500 V/mil thickness.

Standard of Acceptance

- Hart Industrial Unions - fig. D-3136 series
-

- .2 Dielectric insulating flanges - NPS 2-1/2 to NPS 4;
 - .1 Ductile iron flanges, Class 125 to ANSI B16.42.
 - .2 Copper tailpiece for soldered joint,
 - .3 NFPT thread to AMSE B1.20.1 x copper solder joint,
 - .4 BUNA-N gasket,
 - .5 lead free materials to NSF 61+G.
 - .6 maximum design pressure: 1200 kPa (175 psi)
 - .7 maximum operating temperature: 82°C (180°F)

Standard of Acceptance

- Watts No. LF3100

- .3 Dielectric insulated flange – single face with copper tube tailpiece – NPS 2-1/2 to NPS 4;
 - .1 Van Stone style carbon steel flange with copper tailpiece with flared flaired end,
 - .2 carbon steel flange, Class 150 to ANSI B16.5, with powder coated finish.
 - .3 copper tailpiece with rolled flange face-end, and EPDM insulating gasket isolating the copper tube from the steel flange.

Standard of Acceptance

- CTS Flange Canada - fig. CTS Copper Flange Adaptor

- .4 Dielectric Insulating gaskets for flanges NPS 6 and over:
 - .1 for use with standard carbon steel flanges.
 - .2 compatible with pressure and temperature service,
 - .3 BUNA-N or EPDM gasket seals compatible with potable water
 - .4 flange bolts run in insulating sleeves with insulating washers under nuts.

Standard of Acceptance

- Advance Products and Systems

- .5 Provide dielectric isolation between pipes of dissimilar metals with suitable insulating dielectric unions, insulating flanges, or insulating gaskets between flanges;
 - .1 place dielectric isolation between steel piping and bronze or brass valves.
 - .2 do not use bronze or brass valves as dielectric fittings.

◦

5 DRAIN VALVES

- .1 Provide drain points with drain valves at low points of piping systems and at section isolating valves.
- .2 Drain valves: minimum NPS 2 straight pattern bronze with hose end male thread, cap and chain.

6 V-BELT DRIVES

6.1 Products

- .1 Provide V-belt drive for each motor driven device which is not directly connected to the motor. Keep overhung loads on prime mover shafts within manufacturer's design guidelines.
- .2 Sheaves for motors 7.5 kW (10 hp) and less, with not more than two belts:
 - .1 cast iron or steel secured to shafts with removable keys.
 - .2 adjustable pitch on motor, fixed pitch on driven device, giving plus or minus 10% speed range,
 - .3 selected to meet specified operating condition at mid position in pitch adjustment.
- .3 Sheaves for motors greater than 7.5 kW (10 hp) or drives with three or more belts:
 - .1 cast iron or steel with split tapered bushing and keyway.
 - .2 fixed pitch.
- .4 Belts:
 - .1 matched sets of 'B' section, selected for service factor of 2.0 times installed motor horsepower.
 - .2 capable of carrying load with one belt broken.
- .5 Motor slide rails:
 - .1 adjustment plates for centre line alignment
 - .2 belt tension adjusting screws.

6.2 Installation

- .1 Tension belts to manufacturer's recommendations before start-up and after first 100 hr of operation using calibrated belt tensioning gauge.
- .2 Provide replacement pulleys and belts during start-up and balancing to suit field operating conditions.

7 DRIVE AND COUPLING GUARDS

7.1 Products

- .1 Provide guards to protect belt drives, flywheels, rotating couplings on equipment and fan inlet and outlets.
- .2 Guards:
 - .1 removable for servicing,
 - .2 arranged to permit lubrication with guards in place.
- .3 Guards for belt drives:
 - .1 expanded metal screen welded to steel bar stock or angle frame,
 - .2 minimum 1.2 mm (18 ga) thick galvanized sheet metal tops and bottoms,
 - .3 40 mm (1½") diameter holes at both shaft centres for insertion of tachometer.
- .4 Flexible coupling and flywheel guards:
 - .1 Removable "U" shaped, minimum 1.6 mm (16 ga) thick galvanized mild steel or expanded metal mesh on substantial welded angle iron or round barstock frame.
- .5 Guards on unprotected fan inlets and outlets:

- .1 Minimum 20 mm ($\frac{3}{4}$ in) galvanized wire mesh or expanded metal screen with net free area of guard not less than 80% of fan opening.

7.2 Installation

- .1 Belt guards to accommodate movement of motors for belt tension adjustment.
- .2 Where equipment is installed on resiliently mounted base frame or pad, attach belt guard to this base
- .3 Belt guards and fan inlet guards may be omitted where fan and motor is installed in plenum less than 1.4 m (4 ft) high and disconnect for fan motor is mounted adjacent to and outside access door to plenum.
- .4 Fan inlet guards may be omitted where fan is fitted with inlet guide vanes.

8 SLEEVES

8.1 General

- .1 Sleeve pipes, ducts and conduits passing through masonry walls, concrete floors, and fire rated gypsum board ceilings and partitions.
- .2 Maintain fire rating integrity where pipes and ducts pass through fire rated walls, floors and partitions.

8.2 Floor and Wall Sleeves

- .1 Sleeves in fire separations:
 - .1 sized to suit fire stopping methods employed for bare pipes, conduits, insulated pipes, and bare and insulated ducts without fire dampers, and
 - .2 sized to suit conditions of approval given in manufacturers installation instructions for fire and smoke dampers.
- .2 Sleeves in other construction:
 - .1 sized to clear insulated pipes and ducts by 13 mm ($\frac{1}{2}$ in) all round, and
 - .2 sized to clear conduits, bare pipes, and bare ducts by 6 mm ($\frac{1}{4}$ in) all round.
- .3 Sleeves for pipes, conduits and ducts smaller than 0.4 m² (4 sq ft) through solid walls and floors:
 - .1 Schedule 40 steel pipe or 1 mm (20 ga) (minimum) sheet metal, lapped and spot welded.
 - .2 Sleeves for pipes, conduits and ducts smaller than 0.4 m² (4 sq ft) through gypsum board partitions:
 - (a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm ($\frac{3}{4}$ in) lip flange at one end.
- .4 Sleeves for ducts 0.4 m² (4 sq ft) and larger through walls and floors:
 - .1 1.6 mm (16 ga) minimum sheet metal, lapped and spot welded with 20 mm ($\frac{3}{4}$ in) lip flange at one end.
- .5 Manufactured floor sleeves with integral fire stopping:
 - .1 floor sleeve with integrated firestopping, for insulated and non-insulated metal pipes, and plastic pipes,
 - .2 for installation in concrete floors and metal deck/concrete floors,
 - .3 adaptors for support or pipe riser clamps,
 - .4 listed to CAN/ULC-S115.

Standard of Acceptance

- ° Hilti - fig. CP 680 series

8.3 Waterproof Sleeves - Indoors

- .1 Applications:
 - .1 where pipes and ducts pass through floors in areas subject to water, in mechanical rooms, in kitchens, in washing areas and in slabs over electric and telephone rooms.
- .2 Waterproof sleeves for pipes and conduits:
 - .1 Schedule 40 pipe, with 75 mm (3 in) wide annular water bar continuously welded at midpoint, hot dip galvanized to ASTM A123 after fabrication.
- .3 Waterproof sleeves for ducts less than 0.4 m² (4 sq ft):
 - .1 1 mm (20 ga) galvanized steel, with 40 mm (1½ in) flange at midpoint.
- .4 Waterproof sleeves for ducts 0.4 m² (4 sq ft) and larger and openings with multiple ducts:
 - .1 1.6 mm (16 ga) galvanized steel, with 40 mm (1½ in) flange at midpoint, or,
 - .2 form opening with wood (removed after concrete is set) and trim opening with welded steel angle frame 75 mm (3 in) high, bolted to slab and caulked, or,
 - .3 trim opening with 75 mm x 75 mm (3 in x 3 in) continuous concrete curb doweled to slab.
- .5 Modifications for existing construction:
 - .1 annular fins and flanges attached to sleeve at point equivalent to surrounding floor level or curb.

8.4 Foundation Wall Sleeves

- .1 For installation in poured concrete foundation walls.
- .2 Manufactured foundation wall sleeves:
 - .1 PVC wall sleeve with 50 mm (2 in) wide water bar,
 - .2 sized to suit pipe OD and pipe link-seal.

Standard of Acceptance

- ° Metraflex

- .3 Fabricated wall sleeve:
 - .1 schedule 10 carbon steel pipe with 50 mm (2 in) wide water bar welded to mid-point of sleeve, hot dipped galvanized to ASTM A123 *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*, after fabrication,
 - .2 sized to suit pipe OD and pipe link-seal.

8.5 Roof Sleeves for Pipe and Conduit

- .1 Manufacturer roof sleeves:
 - .1 one-piece spun aluminium sleeve, minimum 1.6 mm (0.064 in) wall thickness, with integral continuous welded flashing,
 - .2 insulated with polyurethane insulation for hot and cold piping,
 - .3 with 135° gooseneck for flexible electrical conduit, with minimum clearance from gooseneck outlet to flashing flange of:

- (a) minimum 300 mm (12 in) for installation on conventional roofs,
- (b) minimum 450 mm (18 in) for installation on inverted roofs.
- .4 with vented flashing insert and flashing cap for hot piping,
- .5 with ventilation perforations at top of sleeve and a flashing cap for natural gas piping,
- .6 stainless steel fasteners,
- .7 EPDM base seal between conduit or pipe and bottom of sleeve,
- .8 EPDM top seal, with triple pressure seal, either integral to the sleeve or as a two-piece sleeve and flashing cap,
- .9 sleeve height: 300 mm (12 in),
- .10 suitable for hot and cold piping, with or without pipe insulation, and rigid and flexible electrical conduit.

Standard of Acceptance

- Thaler – fig. MEF series

Application	Thaler Model
Hot piping	MEF-3A
Cold piping	MEF-3A
Natural gas piping	MEF-9
Rigid electrical conduit	MEF-1
Flexible electrical conduit	MEF-2A

8.6 Installation

- .1 Place and secure sleeves in concrete form work.
- .2 Supply sleeves to be set in concrete and masonry walls with installation detail drawings.
- .3 Regular sleeves;
 - .1 terminate flush with surfaces of concrete and masonry walls.
- .4 Waterproof sleeves in new construction;
 - .1 extend 75 mm (3 in) above finished floor.
 - .2 with flange embedded within concrete floor.
- .5 Sleeves in existing concrete and masonry walls and floors;
 - .1 installed in neatly cut or drilled holes in existing construction,
 - .2 cutting and drilling of structural elements, such as floors, slabs, walls, columns, or beams to be carried out in accordance with procedure set out in Article "Cutting and Patching" below.
 - .3 terminate sleeves flush with surfaces of concrete and masonry walls,
 - .4 extend waterproof sleeves 75 mm (3 in) above finished floor with flange, countersunk, and bolted down flush into floor surface,

- .5 fill opening between sleeve and wall or floor with 2 hour fire rated fire-stopping sealant with water barrier.
- .6 Roof sleeves for pipe and conduit:
 - .1 install manufactured roof flashing sleeves in accordance with manufacturer instructions, specifically in accordance with requirements applicable to the type of roofing membrane requirements,
 - .2 where limestone ballast is used, apply asphalt or similar protective coating onto flashing sleeve to a height of 50 mm (2 in) above ballast layer,
- .7 Fill future-use sleeves with weak concrete, gypsum plaster or similar material.
- .8 Coat exposed exterior surfaces of un-galvanized ferrous sleeves with heavy application of zinc rich paint
- .9 At fire separations and smoke separations, pack and seal void between sleeve and pipe, duct without fire damper, conduit, or insulation in accordance with Article "Fire Stopping and Smoke Seals" in this Section.
- .10 At other locations, pack void between sleeve and pipe, conduit, duct or insulation for full depth of sleeve, with mineral wool and seal with silicone-free caulking compound.
- .11 Install fire dampers in accordance with conditions of approval given in manufacturer's instructions.

9 LINK SEALS

9.1 General

- .1 Fit each pipe passing through floor slab in contact with ground or basement walls below grade with link seal between sleeve and bare pipe.
- .2 Submit manufacturer's literature and schedule showing location, service, inside diameter of wall opening, sleeve length and pipe outside diameter.
- .3 Link seal:
 - .1 Manufactured from modular synthetic rubber links with stainless steel hardware.
 - .2 Loosely assembled with bolts to form continuous rubber belt around pipe, with pressure plate under each bolt head and nut.
 - .3 Constructed to provide electrical insulation between pipe and sleeve.

Standard of Acceptance

- Power Plant Supply – fig. Thunderline Linkseal
- Advance Products & Systems – fig. Innerlynx
- Metraflex - fig. MetraSeal

9.2 Installation

- .1 Determine inside diameter of each wall opening or sleeve before ordering seal.
- .2 Position seal in sleeve around pipe and tighten bolts to expand rubber links until watertight seal is obtained.

10 FIRE STOPPING AND SMOKE SEALS

10.1 General

- .1 Provide fire stopping and smoke seals where ducts, pipes or conduits penetrate fire separations.

- .2 Fire stop materials to be impervious to water when installed in a horizontal separation, including waterproof service sleeves.
- .3 Firestop material manufacturer or their designated service representative to provide the following services:
 - .1 selection of listed fire stopping assemblies for each applicable service penetration and fire separation assembly/rating,
 - .2 provide training of contractor's staff for proper installation of fire stopping assembly; create and maintain a log of those personnel who obtain training,
 - .3 inspect the completed installation of all penetrations and submit a written report to the Consultant, including photo record of randomly selected instances of each fire stopping method. Where deficiencies are discovered, note the deficiencies in the report and provide remedial instructions to the contractor to correct the deficiency. After deficiencies are corrected, re-inspect the deficiencies to conform their correction, update and resubmit the report to the Consultant.
- .4 Submit a complete fire stopping and smoke seal shop drawing schedule to the Consultant for review. Include details, cut sheets, system description and location for each proposed fire stopping and smoke sealing application.

10.2 Products

- .1 Materials to form ULC listed or cUL listed/classified assemblies.
 - Standard of Acceptance*
 - Hilti Firestop Systems
 - 3M
 - Nelson Firestop Products
 - Eastern Wire + Conduit (Royal Quickstop)
- .2 Other manufacturers having products with explicitly similar characteristics, listings or classifications and approvals are acceptable.

10.3 Installation

- .1 Install firestopping and smoke seals in accordance with the manufacturer's recommendations and in accordance with its listing.
- .2 Firestopping and smoke seals to be installed only by personnel trained by the manufacturer on the installation of such systems.
- .3 Seal space between penetrating service and sleeve or opening in in fire rated floors and walls with a firestop and smoke sealing system.
- .4 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.
- .5 At time of application of materials, surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials.
- .6 Select firestopping system to allow insulation and vapour barrier to pass un-broken through assembly.
- .7 Do not apply fire stopping materials to fire or smoke dampers.

11 WALL AND FLOOR PLATES

11.1 General

- .1 Provide finishing plates fitted to ducts, pipes, and electrical services provided under Division 20 of the Work which pass through walls, floors and ceilings in finished areas.

11.2 Products

- .1 Escutcheons for small diameter piping and small diameter electrical conduit:
 - .1 manufactured chrome plated two-piece split type with hinge and set-screw.
- .2 Finishing plates for ducts, larger pipes, larger electrical conduits and electrical cables:
 - .1 finishing plate (ring) fabricated from minimum 0.9 mm (20 ga) thick T304 stainless steel with No. 4 brushed finish, with minimum 25 mm (1 in) high collar ring,
 - .2 mounting holes drilled at not less than three (3) symmetrically location positions around the ring to allow mechanical fastening,
 - .3 plate diameter to be sufficiently sized to overlap the wall, floor or ceiling opening by not less than 25 mm (1 in) all around the opening.

11.3 Installation

- .1 Escutcheons;
 - .1 secure escutcheons to pipe and electrical conduit with mechanical fastener.
- .2 Finishing plates:
 - .1 set finishing plates flat against the finished surfaces, and secure to the surface with stainless steel pan-head mechanical fasteners. Provide insert anchor plugs in the finished surface as necessary to secure the fasteners.

12 PIPE SUPPORTS, EQUIPMENT SUPPORTS, HOUSEKEEPING PADS, AND TRENCH COVERS

12.1 General

- .1 Fabricate piping and equipment supplementary supporting steel, and trench and pit covers, from steel and provided by this Division.
- .2 Concrete housekeeping bases for mechanical and electrical equipment which are in direct contact with floor slab, to be provided by this Division.
- .3 Concrete for equipment supported on vibration isolated inertia bases, to be provided by this Division.
- .4 Work to be done by firms specializing in these fields.
- .5 Submit shop drawings for steel and concrete work, prepared by Professional Engineers licensed in the jurisdiction of the Work

12.2 Applicable Codes and Standards

- .1 Legislation:
 - .1 Ontario Building Code,
 - .2 R.R.O. 1990, Reg. 851 Industrial Establishments
- .2 Installation codes and standards:
 - .1 CAN/CSA-S16.1 Limit States Design of Steel Structures.

- .2 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .3 Product standards:
 - .1 ASTM A36 Standard Specification for Carbon Structural Steel
 - .2 ASTM A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .4 ASTM A 307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .5 CAN/CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel.

12.3 Supplementary Supports and Support Brackets

- .1 Provide supplement supports and brackets for the support of equipment, piping and ductwork.
- .2 Fabricate supports from structural grade steel with anchor bolts and fastenings, so that horizontal supporting beam deflections do not exceed 1/360 for the span, and not exceed an absolute deflection of 5 mm (0.20 in), with a safety factor of 1:4 to the ultimate strength of the material
- .3 Design the supports in consultation with the building structural Consultant, to transfer live loads and dead loads to the building structural elements,
- .4 Construct the supports as frames bracketed from walls, and/or supported from building structure above, and/or floor below.

12.4 Roof Platform System

- .1 For the support of piping, ductwork and conduit located on roofs.
- .2 Prefabricated, supported from roof without penetrations, or flashings, made up from:
 - .1 high density polypropylene roof bases
 - .2 2.5 mm (12 ga) formed channel structure
 - .3 1.9 mm (14 ga) supplementary support
 - .4 galvanized steel, traction grip grating
- .3 Manufactured system custom designed for the supported equipment and walkways.

Standard of Acceptance

- Portable Pipe Hangers
- Miro (Unistrut)

12.5 Slide Pads for Equipment Support

- .1 General:
 - .1 slide pads for equipment supports for equipment subject to thermal expansion,
 - .2 designed for continuous-weld and/or tack-welding of backing plate to the equipment support,
 - .3 assembled in pairs per load point.

Standard of Acceptance

° Piping Technologies & Products Inc.

.2 Composite 25% glass-filled PTFE bearing plate bonded to carbon steel backing plate:

- .1 PTFE thickness: 0.1 mm (3/32 in.)
- .2 backing plate: 3 mm (1/8 in.) thick carbon steel plate,
- .3 compressive strength: 19.3 MPa (2800 psi)
- .4 temperature rating: -45 to +260°C (-50 to +500°F)
- .5 coefficient of friction: 0.15

.3 Graphite bearing plate bonded to carbon steel backing plate:

- .1 graphite thickness: 13mm & 6mm (1/2 in & 1/4 in.)
- .2 backing plate: 6 mm (1/4 in.) thick carbon steel plate,
- .3 compressive strength: 19.3 MPa (2800 psi)
- .4 temperature rating: -45 to +537°C (-50 to +1000°F)
- .5 coefficient of friction: 0.15.

12.6 Trench Covers, and Pit Covers

.1 Fabricated with:

- .1 75 mm x 75 mm x 9.5 mm (3 in x 3 in x 3/8 in) welded angle frame with anchor bars,
- .2 25 mm x 9.5 mm (1 in x 3/8 in) trim bar to fit concrete pit, and with matching checker-plate cover,
- .3 hot dip galvanized after fabrication

12.7 Concrete Bases for Housekeeping Pads

- .1 Constructed using plywood form work and 20 MPa (3000 psi) concrete.
- .2 Doweled to concrete floor slab with not less than 13 mm (1/2 in) diameter steel rods. For existing concrete floors, floors are to be drilled and dowels secured in the holes with chemically-hardening adhesive.
- .3 Refer to Specification section 20 05 49 *Seismic Restraint for Mechanical Systems* for additional requirements for housekeeping pads where equipment is to be seismically restrained.
- .4 Finish to make flat, level, smooth, neat surfaces.
- .5 Chamfer corners 25 mm (1 in).
- .6 Plan dimensions:
 - .1 75 mm (3 in) larger all around than base of apparatus for non-seismic applications,
 - .2 minimum 200 mm (8 in) larger all around than equipment-base anchor attachment points for seismically restrained equipment.
- .7 Height conforming to following table;

Equipment Type	Floor Type	Vibration Isolation	Thickness of Housekeeping Pad mm (in)
Stationary, not motorized	All	All	100 (4)
Motorized, up to 7.5kW (10 HP)	All	---	150 (6) (max. for fans)

Equipment Type	Floor Type	Vibration Isolation	Thickness of Housekeeping Pad mm (in)
Motorized, 11 to 19kW (15 to 25 HP)	Slab on Grade	No	250 (10)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)
Motorized, 22kW (30 HP) and over	Slab on Grade	No	300 (12)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)

12.8 Installation - General

- .1 Locate supporting steel to permit removal of parts for service or repair, and to allow clear access to valves, fittings, and equipment,
- .2 Set equipment on supporting frames and brackets and install hangers, anchor bolts, vibration mountings and snubbers.
- .3 Set equipment base plates on housekeeping pads on minimum 13 mm (½ in) epoxy grout and fill hollow portion of base with concrete.
- .4 Install anchor bolts, vibration mountings and snubbers between equipment and housekeeping pad, or inertia pad and housekeeping pad.
- .5 Provide anchorage, dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .6 Make field connections with bolts to CAN/CSA-S16.1, or by welding.
- .7 Supply items for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .8 Touch-up field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .9 Where trench covers are cut in field or damaged, touch up with zinc rich paint.

13 INSTALLATION OF EQUIPMENT SUBJECT TO THERMAL EXPANSION

- .1 The following specific installation requirements apply to hot equipment which is not supported on spring vibration isolators, including but not limited to:
 - .1 boilers, hot water heaters,
 - .2 heat exchangers,
 - .3 expansion tanks,
 - .4 deaerators and condensate tanks,
 - .5 diesel exhaust SCR emission control units.
- .2 Fasten equipment to building structure to accommodate thermal expansion in accordance with manufacturer's instructions. In the absence of such instructions, fasten equipment support legs as follows unless otherwise shown;
 - .1 rigidly mechanically-fasten one fixed support point which is closest to the inlet exhaust piping connections,

- .2 for supports located on the same transverse or longitudinal axis as the fixed support point, provide slide guides with lateral limit-stops (lateral to the direction of thermal movement) with a lateral clearance gap not exceeding:
 - (a) 6 mm (1/4 in.) lateral movement for outdoor equipment and/or equipment subject to seismic restraint,
 - (b) 12 mm (1/2 in.) total movement otherwise.
 - .3 for other support points, provide guides with two-axis horizontal limit-stops to allow free movement under thermal conditions,
 - .4 when installed outdoors, or where subject to seismic restraint, or both, provide vertical movement limit stops to limit free movement due to wind loading or seismic forces to not more than 6 mm (1/4 in.).
-
- .3 Provide support slide pads beneath each support leg other than the fixed support;
 - .1 use PTFE slide pads for equipment with an operating temperature less than 260°C (500°F),
 - .2 use graphite slide pads for equipment with an operating temperature greater than 260°C (500°F).

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

PAINTING FOR MECHANICAL SERVICES

20 05 02

1 GENERAL

1.1 Scope

- .1 Provide industrial sealer and anti-corrosion coatings for mechanical and electrical building services and related construction elements including:
 - .1 mechanical and electrical services and supporting elements as specified under other sections of Divisions 20 to 25,
 - .2 concrete curbs, housekeeping pads, and floor trenches,
- .2 Decorative finish painting of building services is provided under Division 09.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 01 01 Mechanical General Requirements
 - .2 20 05 01 Mechanical Basic Materials and Methods
 - .3 23 11 13 Fuel Oil Piping and Accessories
 - .4 23 11 23 Natural Gas Systems.
- .2 In addition to building elements to be painted as specified herein, refer to other Specification sections of Division 20 to 25 for other mechanical equipment to be painted.

1.3 Submittals

- .1 Submit product data sheets which demonstrate compliance with LEED VOC requirements.

1.4 Applicable Codes and Standards

- .1 Legislation:
 - .1 SOR/2009-264 Canadian Environmental Protection Act, *Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations*
- .2 Installation standards and codes:
 - .1 LEED v4 New Construction, credit EQ Cr 4.2
 - .2 SSPC-SP1 Solvent Cleaning
 - .3 SSPC-SP2 Hand Tool Cleaning
 - .4 SSPC-SP11 Bare Metal Power Tool Cleaning
 - .5 SSPC-SP13 Surface Preparation of Concrete
- .3 Product standards:
 - .1 Green Guard GC-03 Green Seal Environmental Criteria for Anti-Corrosion Paints

2 PRODUCTS

2.1 Industrial Anti-Corrosion Coatings – Carbon Steel Materials

.1 Outdoor applications:

- .1 For carbon steel materials and structural steel support components.
- .2 Top coat: Industrial urethane alkyd enamel top coat, or single compound 100% acrylic coating.
- .3 Primer coat: as per manufacturers' recommendation for coating of steel piping.
- .4 Colour: Sherwin Williams No. SW4027 (Galvano), unless specified elsewhere.
- .5 VOC limit: 340 g/L of product less water and excluded compounds.

Standard of Acceptance

- Sherwin Williams – Pro Industrial Urethane Alkyd Enamel
- Sherwin Williams – Pro Industrial Acrylic

.2 Indoor applications:

- .1 For carbon steel materials and structural steel support components.
- .2 Top coat: single compound 100% acrylic coating.
- .3 Primer coat: as per manufacturers' recommendation for coating of steel piping.
- .4 Colour: Sherwin Williams No. SW4027 (Galvano), unless specified elsewhere.
- .5 LEED: certified to Green Guard standard GC-03 for anti-corrosion coatings.
- .6 VOC limit: 250 g/L of product less water, U.S. EPA method 24.

Standard of Acceptance

- Sherwin Williams – Pro Industrial Acrylic

.3 Zinc rich primer applications:

- .1 For field painting of carbon steel material, or touch-up of galvanized steel material.
- .2 Top coat: as specified for interior or exterior applications.
- .3 Primer: single or multi-part zinc rich coating.
- .4 Colour: gray-green.
- .5 LEED: certified to Green Guard standard GC-03 for anti-corrosion coatings.
- .6 VOC limit: 250 g/L of product less water, U.S. EPA method 24.

Standard of Acceptance

- Sherwin Williams – Zinc Clad III HS 100

2.2 Industrial Coatings – Poured Concrete

.1 For field painting of concrete floor trenches, housekeeping pads, curbs and floor areas in specified service rooms.

- .1 Resistant to fuel oil, general solvents and water.
- .2 Top coat: water based urethane floor enamel
- .3 Primer: water based epoxy

- .4 Colour: Sherwin Williams Deck Gray
- .5 Colour: Sherwin Williams Safety Yellow where shown.
- .6 VOC limit: 250 g/L of product less water, U.S. EPA method 24.

Standard of Acceptance

- ° Sherwin Williams – Armorseal Floor Plex 7100 Primer / Amorseal 1K Topcoat

3 EXECUTION

3.1 General

- .1 Refer to requirements for services to be painted in the relevant sections of Division 20 to 25 and as specified herein, including but not limited to:
 - .1 general requirements for painting in accordance with Specification section 20 01 01,
 - .2 painting of pipe sleeves in accordance with Specification section 20 05 01,
 - .3 painting of fuel oil piping in accordance with Specification section 23 11 13,
 - .4 painting of natural gas piping in accordance with Specification section 23 11 23.

3.2 Repair of Factory Coatings

- .1 Touch up any damage to factory prime coat finishes resulting from shipping or installation with appropriate primer for indoor/outdoor installation followed by an appropriate top-coat colour to match existing. Materials to be compatible with the original factory finish.
- .2 Touch up any damage to factory galvanized finish resulting from site welding, shipping or installation with zinc rich primer.

3.3 Paint Installation

- .1 Surface preparation and protection:
 - .1 Clean surfaces to be painted in accordance with paint manufacturer recommendations and as follows.
 - .2 Surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials at time of application of paint materials.
 - .3 For carbon steel materials, remove all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by hand chipping, scraping, sanding, and wire brushing in accordance with SSPC-SP2 or use power tool cleaning in accordance with SSPC-SP11
 - .4 For galvanized steel material, solvent clean to SSPC-SP1. If galvanized surface is already rusty, remove loose rust and dirt in accordance with SSPC-SP2 or SSPC-SP11 and prime the exposed metal the same day as being cleaned.
 - .5 For concrete materials, clean surfaces to SSPC-SP13 / NACE 13 by mechanical, chemical or thermal methods.
 - .6 Tape-off adjacent materials which are not to be painted.
 - .7 Provide drop sheets to protect other material from falling paint or over-spray.

- .2 Application - General:

- .1 Apply one coat of primer to carbon steel items.
 - .2 Use primer unadulterated, as prepared by manufacturer.
 - .3 Apply top coat in the number of coats recommended by the manufacturer, to obtain 100% coverage to the minimum recommended thickness, free of streaks, drips and sags.
 - .4 Do not paint when temperature is lower than 7°C.
- .3 Application – Galvanized base metal finish:
- .1 Where material is galvanized, touch up welded sections or other locations where protective galvanized surface has been damaged, with zinc rich primer.
 - .2 Apply a top coat to match base material colour.
- .4 Application – Concrete trenches, housekeeping pads, curbs and floors:
- .1 Apply one coat of primer and two top-coats.
 - .2 Seal joints between floors and curbs or housekeeping pads, and between floors and walls , with a silicone based industrial caulking in matching colour after paint has dried.

End of Section

COMMON ELECTRICAL REQUIREMENTS FOR MECHANICAL SERVICES

20 05 12

1 GENERAL

1.1 Scope

- .1 Provide wiring, conduit, fittings, supports, disconnect switches, service lights, and related devices and equipment for mechanical trades work, to the extent specified herein.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 29 Hangers and Supports
 - .2 20 05 49 Seismic Restraint.
 - .3 20 05 14.13 Motor Controllers
 - .4 20 05 14.16 Variable- Frequency Drives
 - .5 25 55 13 Building Automation Smoke Damper Control Panels

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section and referenced sections:
 - .1 **Control panels** – an electrical device that controls or monitors mechanical equipment, or that interfaces with instrumentation devices.
 - .2 **Control wiring** - wiring for the purpose of communication or control of equipment and instrumentation.
 - .3 **Electrical safety code** - the edition with amendments of CSA C22.1 as adopted by applicable legislation at the location of the Work.
 - .4 **Mechanical breaker panel (MBP)** means a 120/208 V mechanical power panel with overcurrent protection circuit breakers provided as part of an MCC.
 - .5 **Mechanical service panel (MSP)** - panelboard with branch circuit overcurrent protection devices provided by Division 26, and dedicated to supply power for equipment provided by mechanical trades work.
 - .6 **Mechanical trades work** - equipment and systems provided under Divisions 20 to 25.
 - .7 **Motor controllers** - constant speed motor controllers of the manual, magnetic or solid-state type in accordance with specification section 20 05 14.13.
 - .8 **Motor Control Center** – has the meaning as specified in section 20 05 14.13.
 - .9 **Packaged equipment** - equipment containing some or all of: motor(s), controls and/or other electrically powered equipment, such as but not limited to: electric heating equipment, water treatment equipment, packaged HVAC equipment, electric boiler, electric domestic water heaters, etc.)
 - .10 **Power Panel (PP)**: 208 up to 600 V, 3 phase, panelboard with branch circuit overcurrent protection devices provided by Division 26, which serves general building loads and may also serve equipment provided by mechanical trades work.
 - .11 **Power wiring** means wiring that provides electrical power to equipment including to control panels, including BAS panels, that are not integral to the controlled equipment.

- .12 **Receptacle panel (RP)** - a 120/208 V panelboard with branch circuit breakers, provided by Division 26.
- .13 **SCCR**: the RMS symmetrical short-circuit current rating of the motor controller, measured at the output of the controller (short-circuit withstand rating has the same meaning).
- .14 **VFD**: variable frequency drives in accordance with specification section 20 05 14.16.
- .15 **Wiring** means conductors, cable, conduit, fittings, supports and accessories.
- .2 With respect to these definitions, for equipment provided by Division 26 the actual terminology used in the Division 26 drawings and specification may differ but the intent remains the same.
- .3 For clarity, any reference herein to Division 20 means Divisions 20 to 25 inclusive.

1.4 Applicable Codes and Standards

- .1 Legislation:
 - .1 Electrical safety legislation in the jurisdiction of the Work.
 - .2 For clarity, on Federal Government projects, comply with the provincial or territorial legislation at the place of the Work which adopts the applicable edition of CSA 22.1 with any amendments
- .2 Installation standards and codes:
 - .1 CSA C22.1 Canadian Electrical Code Part 1, as amended and adopted by the AHJ for electrical safety in the province or territory at the place of the Work.
- .3 Product standards:
 - .1 CSA C22.2 No. 4 Enclosed and Dead-Front Switches
 - .2 CSA C22.2 No. 38 Thermoset-Insulated Wires and Cables
 - .3 CSA C22.2 No. 39 Fuseholder Assemblies
 - .4 CSA C22.2 No. 106 HRC – Miscellaneous Fuses
 - .5 CSA C22.2 No. 124 Mineral Insulated Cable
 - .6 CSA C22.2 No. 131 Type TECK 90 Cable
 - .7 CSA C22.2 No. 208 Fire Alarm and Signal Cable
 - .8 CSA C22.2 No. 230 Tray Cable
 - .9 CSA C22.2 No. 239 Control and Instrumentation Cables

1.5 Quality Control

- .1 Electrical wiring for mechanical trades work to be performed by a specialist electrical contractor firm with an established reputation in the field of wiring of mechanical equipment and controls.

1.6 Permits, Fees and Inspections

- .1 Arrange and pay for electrical permits and any required inspections for electrical work for mechanical equipment and systems.
- .2 Submit to the electrical safety authority the required number of drawings and specifications for examination and approval prior to commencement of work.
- .3 Notify Consultant of changes required by the electrical safety authority prior to making changes.
- .4 On completion of the Work, furnish certificates of acceptance (or similar report) from the electrical safety authority to the Consultant.

1.7 Standard Details

- .1 Device legend with list of abbreviations and schematic wiring diagrams are included at the end of this section that delineate the scope of work between Division 20 and Division 26 and as further specified herein.
- .2 This material is to be used in the interpretation of specification requirements for power wiring and control wiring of Division 20 to 25 equipment.

1.8 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
 - .1 VFD Inverter Duty cable,
 - .2 service lights.

1.9 Storage of Materials

- .1 Store wire and cable in a clean, dry, well-ventilated area.
- .2 Protect white insulated wire from exposure to NOx gas (e.g.: exhaust from propane fueled equipment) by wrapping with shrink wrap, by locating away from sources of NOx and by maintaining adequate ventilation to minimize NOx levels.
- .3 Where white insulated wire has discoloured:
 - .1 do not install,
 - .2 dispose of the wire,
 - .3 remove and replace wire that has been installed.

2 PRODUCTS

2.1 Motor Feeder and Control Wiring (“Building Wires”)

- .1 Application:
 - .1 motor and equipment power feeders controlled by constant speed motor controllers;
 - (a) do not use for motors controlled by variable frequency drives,
 - .2 control wiring including control valves and damper actuators, panel control wiring, motor controller interlock wiring, BAS control wiring, and switch-type instrumentation,
 - .3 convenience power outlets and service lights.
- .2 Conductors:
 - .1 solid copper for No. 12 and 14 AWG,
 - .2 stranded conductors for 10 AWG and larger.
- .3 Minimum wire size:
 - .1 No. 12 AWG for equipment power,
 - .2 No. 14 AWG, for control wiring at 120 VAC or lower.
- .4 Insulation:
 - .1 chemically cross-linked thermosetting polyethylene (XLPE) material, RW90 or RWU90,
 - .2 1000 V insulation for 600 V systems,
 - .3 600 V insulation for 100 VAC to 480 VAC systems.

- .4 300 V insulation for systems less than 100 VAC, and for systems 24 VDC and less.
- .5 Colour coded conductors:
 - .1 colour impregnated into insulation at time of manufacture,
 - .2 phase conductors No. 8 AWG and larger with black insulation, may be colour coded with adhesive colour coding tape.
- .6 Listed to CSA C22.2 No. 38.

Standard of Acceptance

- Aetna Insulated Wire
- General Cable
- Nexans Canada Inc.
- Prysmian Cables & Systems Ltd.
- Southwire

2.2 VFD Inverter Duty Cable

- .1 Application:
 - .1 for motor power feeders between a VFD and its driven motor,
 - .2 specifically manufactured to reduce high frequency noise and grounding of common mode currents.
- .2 Cable:
 - .1 symmetrical conductor, low-capacitance design with three ground wires and shield,
 - .2 conductors: braided copper wire with RW90 XLPE insulation.
 - .3 voltage rating: 1000 VAC, with resistance to voltage spikes of not less than 2 kV.
 - .4 bonding conductors: three (3) bare copper conductors,
 - .5 shielding:
 - (a) designed for EMC/RFI reduction and as a low-impedance path for high-frequency common mode currents,
 - (b) 100% coverage by two-layers of copper-wrap tape shield, or
 - (c) shielding provided by continuous corrugated and welded aluminium armoured sheath.
 - .6 sheath:
 - (a) method 1: continuous corrugated and welded aluminum armour sheath (armour and shield),
 - (b) method 2: interlocked aluminium sheath for armour, separate copper wrap shields as specified above,
 - (c) method 3: no armour sheath required when cable has the specified copper tape shielding and is installed in conduit,
 - .7 outer jacket: TPE or PVC liquid-tight with FT4 and AG14 rating, and UV resistant.
 - .8 listed to CSA C22.2 No. 38, and CSA C22.2 No. 230.

Standard of Acceptance

- NEXANS - fig. DriveRx (armoured)
- ShawCor - fig. CSA Armoured AIA VFD (armoured)
- ShawCor - fig. CSA Unarmoured Tray VFD (unarmoured)

- Belden - fig. Symmetrical 2kV (unarmoured)
- Belden - fig. Symmetrical 2kV (armoured)

.3 Cable shield termination fittings:

- .1 High-frequency/low impedance shield termination kit to provide 360° connection to the cable shield, with flexible tinned copper braid bonding strap with attached lug, and constant force spring collar.

Standard of Acceptance

- Southwire – fig. 85451

- .2 High-frequency/low impedance cable gland, with integral 360° copper alloy shield contact spring.

Standard of Acceptance

- Southwire - fig. 85452

2.3 Instrumentation Cabling

- .1 Application: instrumentation and control wire suitable for analogue 4-20 mA and 0-10 VDC signaling.
- .2 Cable:
- .1 insulated solid-copper twisted-multipair conductors, shielded cables with individually shielded pairs, 100% coverage overall shield, drain wires and overall rated jacket,
- .2 insulation: XLPE, colour coded or numbered wires,
- .3 minimum wire size: as specified by equipment manufacturer or controls vendor, but not less than 18 AWG,
- .3 Armour:
- .1 corrugated steel, or
- .2 none required if installed in conduit or approved wireway.
- .4 Jacket:
- .1 FT4 flame retardant,
- .2 FT6 when installed in open style cable trays in ceiling spaces that are used as return air plenums.
- .5 Listed to CSA C22.2 N0. 239,

Standard of Acceptance

- General Cable (Carol)
- Belden
- Nexans Canada Inc.

2.4 Fire Rated Mineral Insulated Cable

- .1 Application – power feeders:
- .1 conductors: solid annealed copper,
- (a) 2 conductors, minimum 14 AWG for power wiring for Division 20 to 25 control equipment including dampers and terminal units,
- (b) 2 or 3 conductor as applicable, size as shown but not less than 12 AWG for power wiring to Division 20 to 25 mechanical equipment (other than control equipment)
- .2 insulation: compacted magnesium oxide (“MI”)

- .3 sheath: seamless annealed copper.
- .4 voltage rating: 600 V
- .5 terminations: as supplied by the cable manufacturer.
- .6 fire rating: listed for 2 hour fire-resistance rating with hose stream test to ULC-S139 cables labelled accordingly.
- .7 ship cables with ends sealed.
- .8 listed to CSA C22.2 No. 124 and ULC-S139.

Standard of Acceptance

- ° Pentair/Pyrotenax System 1850
- .2 Application - communication wiring:
- .1 conductors: solid annealed copper, single twisted pair 18 AWG.
 - .2 insulation: compacted magnesium oxide ("MI")
 - .3 shield: seamless annealed copper.
 - .4 secondary insulation: compacted magnesium oxide ("MI").
 - .5 sheath: seamless annealed copper.
 - .6 voltage rating: 300 V.
 - .7 terminations: as supplied by the cable manufacturer.
 - .8 listed for fire alarm cabling CSA FAS 105.
 - .9 fire rating: 2 hour fire-resistance rating with hose stream test to ULC-S139.
 - .10 ship cables with ends sealed.
 - .11 listed to CSA C22.2 No. 208 and ULC-S139.
 - .12
 - ° Pentair/Pyrotenax System 1850 Twisted Pair

2.5 Fire Rated Ceramifriable Silicone Rubber Insulated Cable

- .1 Application: controls and communications wiring.
- .1 No of conductors:
 - (a) single twisted pair for control and BAS MSTP communication,
 - (b) 4x shielded twisted-pair for Ethernet communications.
 - .2 conductors: annealed copper, 18 AWG, with flame retardant tape cover,
 - .3 insulation: thermoset ceramifriable silicon rubber, colour coded red/black,
 - .4 drain wire: 20 AWG copper,
 - .5 shield: copper/polyester tape,
 - .6 jacket: low smoke, zero halogen polyolefin, red colour,
 - .7 voltage rating: 72 V maximum,
 - .8 fire rating: 2 hour fire-resistance rating with hose stream test to ULC-S139,
 - .9 listed to CSA C22.2 No. 208 and ULC-S139.

Standard of Acceptance

- Vitalink (Marmon, Comtran) FAS 105

2.6 Conduits and Fittings

.1 Conduits:

- .1 rigid hot dipped galvanized steel threaded conduit,
- .2 electrical metallic tubing (EMT), hot dipped galvanized with couplings,
- .3 PVC coated hot dipped galvanized rigid steel conduit: with 40 mil PVC exterior coating, 2 mil urethane interior and thread coating,
- .4 flexible metal conduit and liquid-tight flexible metal conduit.

.2 Conduit fastenings:

- .1 single hole steel straps to secure surface conduits 50 mm (2") and smaller,
- .2 two hole steel straps for conduits larger than 50 mm (2"),
- .3 beam clamps to secure conduits to exposed steel work,
- .4 channel type supports for two or more conduits,
- .5 Ø6 mm threaded rods to support suspended channels.

.3 Conduit fittings:

- .1 manufactured for use with conduit specified including coatings,
- .2 factory "ells" where 90° bends are required for 25 mm (1in.) and larger conduits,
- .3 insulated throat steel set screw or raintight insulated throat steel compression connectors and couplings for EMT,
- .4 threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit,
- .5 raintight insulated throat steel connectors at all surface equipment enclosures and other electrical equipment in sprinklered areas for all conduit terminations.

2.7 Outlet Boxes

.1 Construction:

- .1 hot dipped galvanized steel single and multi-gang flush device boxes for flush installation,

.2 Size:

- .1 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated,
- .2 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

2.8 Disconnect Switches

.1 Construction:

- .1 listed to CSA C22.2 No. 4,
- .2 enclosure type:
 - (a) painted metal with hinged door,
 - (b) indoors: type 1 with sprinkler shield, 3R, 4 or 12, unless otherwise shown,

- (c) outdoors: type 3R.
- .3 fuseholder assemblies listed to CSA C22.2 No. 39,
- .4 fused unless shown as unfused,
- .5 fuseholders suitable for Class J fuses, sized to suit the fuse sizes without the use of adaptors,
- .6 horsepower rated,
- .7 one, two or three pole as required for single phase or polyphase circuits,
- .8 two pole with solid neutral or three pole with solid neutral for three wire and four wire circuits with neutral,
- .9 six pole for two speed motor applications,
- .10 provision for padlocking in the Off switch position,
- .11 mechanically interlocked door to prevent opening when handle is in the ON position,
- .12 heavy duty, quick-make, quick-break action,
- .13 ON-OFF switch position indication on switch enclosure cover.
- .2 Fuses:
 - .1 HRCI-J time delay up to 600A,
 - .2 HRCI-L for ratings above 600A,
 - .3 minimum interrupting capacity: 200 kAIC
 - .4 product of one manufacturer,
 - .5 ampere rating as indicated, where not indicated, the maximum rating permitted by the electrical code.
- .3 Special requirements for disconnect switch located between a VFD and the controlled equipment:
 - .1 auxiliary switch position status switch;
 - (a) rating: 10 A at 120 VAC,
 - (b) switch contacts open when disconnect switch is Not-Closed.
- .4 Ratings:
 - .1 IEC 90 rotary switch for motors up to 18.6 kW (25 HP),
 - .2 NEMA flange mount switch-handle for all ratings.

Standard of Acceptance

- Square "D"/Schneider Electric Company (Canada) Ltd.
- Eaton
- Siemens Canada Ltd.
- Klockner Moeller/Eaton

2.9 Equipment Service Lights

- .1 Protected globe light fixture ("Marine light"):
 - .1 die-cast aluminium housing and cage, frosted glass lens, stainless steel hardware, suitable for wall and ceiling mounting,
 - .2 enclosure rating: NEMA 4X or IP 65, vapourtight,

- .3 listed and fixture marked for use in wet locations,
- .4 bulb: LED with electronic driver, minimum life of 50,000 hours at L70 lumen level,
- .5 optics: 3500 to 4000 K light, nominally 1400 lumens,
- .6 operating temperature: -20 to +40°C (-4 to +104°F),
- .7 operating humidity: up to 100% relative humidity at operating temperatures between 0 and +40°C (32 to 104°F),
- .8 power: 120 VAC.

Standard of Acceptance

- Cooper - fig. LVL20UG

.2 Area light fixture ("Area light"):

- .1 reinforced-polyester fiberglass housing, stainless steel hardware, with lens gasket, suitable for wall and ceiling surface-mounting,
- .2 fixture length: 600 mm (24 in),
- .3 lens: low profile, high impact 50% DR acrylic lens, for wide distribution,
- .4 enclosure rating: NEMA 4X or IP 65, vapourtight,
- .5 listed and fixture marked for use in wet locations,
- .6 bulb: LED with electronic driver, minimum life of 60,000 hours at L80 lumen level,
- .7 optics: 3500 to 4000 K light, nominally 3000 lumens,
- .8 operating temperature: -20 to +40°C (-4 to +104°F),
- .9 operating humidity: up to 100% relative humidity at operating temperatures between 0 and +40°C (32 to 104°F),
- .10 power: 120 VAC.

Standard of Acceptance

- Cooper - fig. 2VT3
- Lithonia - fig. FEM LED

2.10 Switches

- .1 Toggle switch, with neon pilot light – light is On when switch is Off.
- .2 Rating: 20 A at 120 Vac.
- .3 Switch cover: weatherproof with silicone rubber gasket, and clear bubble over toggle.

Standard of Acceptance

- Hubbell - HBL1795

2.11 Receptacles

- .1 Class A GFCI type, 15 A at 120 VAC indoors, and 20 A T-slot for outdoors.
- .2 Receptacle outlet hood:
 - .1 in-use weatherproof, for both indoor and outdoor locations,
 - .2 die cast aluminum base and cover with gasket,

- .3 vertical mount.
- .4 self-closing lift cover.
- .5 CSA 3R rated.

Standard of Acceptance

- Bryant Electric – WPB26EH

2.12 Rooftop Maintenance Receptacle Pedestals

- .1 Manufactured roof-mounted maintenance receptacle pedestal;
 - .1 formed galvanized steel with powder coat finish, or stainless steel square tube,
 - .2 roof deck mounting flange, for bolting from the top of flange to roof, or fastened using a two part deck flange assembly,
 - .3 minimum height above roof: as required for receptacle to be located at not less than 750 mm (30 in.) above the roof flange,
 - .4 receptacle: Class A GFCI type, 120 V, 20 A T-slot, with in-use weatherproof receptacle cover,
 - .5 factory-wired or field wired. For factory wiring, minimum no. 12 AWG RW90 conductors in liquid-tight flexible metallic conduit.
 - .6 CSA Type 3R rated.

Standard of Acceptance

- Valid Manufacturing fig. Rooftop Pedestal
- MAPA fig. MPX series]

2.13 Conduit and Equipment Supports

- .1 Carbon steel supports, hot dipped galvanized after fabrication.
- .2 Manufacturer standard products suitable for support load rating of conduit and conductors,

Standard of Acceptance

- Burndy Canada Ltd.
- Canstrut
- Electrovert Ltd.
- E. Myatt & Co. Ltd
- Steel City Electric Ltd.
- Pilgrim Technical Products Ltd.

- .3 Upper attachment – concrete inserts
 - .1 galvanized wedge inserts to MSS SP-58 type 18.
 - .2 maximum tension load rating: 4.4 kN (1000 lbs),

Standard of Acceptance

- Anvil - fig. 281
- Unistrut - fig. P-3245

- .4 Upper attachment – existing concrete:
 - .1 surface mount clevis plate, for mounting to concrete,

- .2 carbon steel plate with clevis and malleable iron socket with bolt, and weldless eye nut.

Standard of Acceptance

- Anvil - fig. 49 clevis plate, Fig. 290 weldless eye nut
- Myatt - fig. 535 socket, Fig. 480 weldless eye nut

- .3 threaded inserts for drilled holes.

Standard of Acceptance

- Hilti - fig. HDI, Kwick Bolt, HSL

- .5 Upper attachment – steel beams:

- .1 carbon steel beam clamp (top flange), hook rod with locking jaw, fasteners and lockwashers, to MSS SP-58, type 25,

Standard of Acceptance

- Anvil - fig. 227
- Myatt - fig. 504, 505

- .6 Upper attachment - steel joists:

- .1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints for support on the lower chord,
- .2 carbon steel washer plate with double locking nuts on top-side of washer,
- .3 second steel washer plate on underside of joist with nut where supported equipment is subject to vibration.

Standard of Acceptance

- Anvil - fig. 60
- Myatt - fig. 545

- .7 Hanger rods:

- .1 continuous threaded rod, carbon steel, USS national course thread,
- .2 tension load ratings to MSS SP-58,

Standard of Acceptance

- Anvil - fig. 146
- Myatt - fig. 434

- .8 Horizontal Pipe Support – Swivel Ring Hanger

- .1 swivel ring hangers, carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,
- .2 nominal conduit size: 12mmC to 100 mmC.

Standard of Acceptance

- Anvil - fig. 69, CT-69
- Myatt - fig. 41, 42, 43
- Unistrut

.9 Rooftop conduit supports:

.1 conform to specification section 20 05 29.

2.14 Wire Markers

.1 Printed, self-laminating vinyl wire and cable labels and sleeve-labels.

Standard of Acceptance

- Brady BMP21 Plus series

3 EXECUTION

3.1 General

- .1 Install electrical wiring work under this specification section in accordance with the applicable electrical safety code and regulations applicable at the location of the Work.
- .2 In other than service rooms, run conduit and cable concealed within walls or above ceilings.
 - .1 for open-cell concrete block walls, install conduit during wall construction with openings for outlet boxes,
 - .2 for solid concrete walls, rough-in conduit and outlet boxes supported from structural reinforcing bars prior to pouring of concrete,
 - .3 where walls or ceiling structures are exposed, such as steel or finished concrete, arrange conduit neatly on the supporting surface, avoid the use of elbows to the greatest extent possible, and locate conduit as close as possible to the building structure.
- .3 In service rooms, run conduit and cables exposed.

3.2 Conduit Support and Hanger Installation

- .1 As an alternative to the materials specified herein, specification section 20 05 29 may also be used for support of conduits.
- .2 Support conduit from building structure in accordance with specification section 20 05 29.
- .3 Support conduit directly from or on structural building elements. Do not support conduit directly from other services.
- .4 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete support installation.
- .5 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.
- .6 In steel framed construction, support conduit from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;
 - .1 fabricate supplementary steel from standard HSS sections, single EL section, double C "strongback" sections, or pipe rolls,
 - .2 size supporting steel to limit span deflection to 1/250 (0.4%) between support points,
- .7 Support horizontal conduit at intervals not exceeding 3 m (6 ft).
- .8 Support vertical conduit at intervals not exceeding 3 m (6 ft).

- .9 Where trapeze hangers are used, secure conduit to trapeze with U-bolts.
- .10 Mechanically fasten supplementary steel to structural steel.

3.3 Installation of Power and Control Wiring – General Requirements

- .1 Wiring methods and standards to conform with those specified in Electrical Division 26 for the area of building in which installation is to be made, except as otherwise specified in this section.
- .2 Except where fire rated cables or VFD Inverter duty cables are required, use building wire for:
 - .1 power wiring for motors and packaged equipment,
 - .2 power wiring to control panels, heat tracing and other non-motorized packaged equipment, and
 - .3 non-analog control wiring at 120 VAC or less, and 24 VDC or less.
- .3 Provided polyphase motor and equipment power conductors with the following colour coding:
 - .1 Phase A – Red,
 - .2 Phase B – Black,
 - .3 Phase C – Blue ,
 - .4 Neutral - White,
 - .5 Ground - Green,
 - .6 Control - Orange.
 - .7 Where colour coded tape is utilized, apply at least 50 mm (2") at terminations, junction boxes and pull boxes. Do not paint conductors.
- .4 Provide single-phase motor and control wiring conductors with the following colour coding:
 - .1 Line – Red,
 - .2 Neutral – White,
 - .3 Ground – Green.
- .5 Install all wiring in conduit or approved raceway.
- .6 Conduit selection type:
 - .1 EMT: Use thin wall conduit up to and including 32 mm (1 ¼ in) size for wiring in ceilings, furred spaces, in hollow walls and partitions and where not exposed to mechanical injury, and as otherwise shown.
 - .2 Rigid : Use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 40 mm (1½ in) size and larger.
 - .3 Liquid-tight flexible: use only for the last 1000 mm (3 ft) of motor feeder at connection to motor, and for instrumentation wiring to equipment subject to vibration.
 - .4 Select conduit size to be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.
- .7 Provide separate conduit for power wiring for each motor or starter. Except for motor temperature transducer wiring, do not install control wiring in the same conduit as power wiring.
 - .1 exception: motor temperature transducer wiring between motor and associated motor controller may be run in the same conduit as the associated motor feeder provided the conduit is sized for the additional wire pair.

3.4 Installation of Power Wiring for VFDs and Associated Motors

- .1 Use VFD inverter duty cables for motor feeders between VFDs and associated motor.
- .2 Run VFD inverter duty cables in rigid conduit or EMT between the VFD and the motor, with liquid-tight flexible conduit used at the motor connection;
 - .1 use only site-formed bent elbows for changes of direction; do not use ells,
 - .2 make an elbow radius so that the bend radius of the cable is not less than the minimum bending radius specified by the cable manufacturer,
 - .3 do not combine wiring from any other source or purpose within VFD feeder conduit.
- .3 VFD inverter duty cables may be run in free- air (without conduit) where all the following conditions are met;
 - .1 the VFD cable is armoured type,
 - .2 the armoured cable is located in the same room as the VFD and the motor,
 - .3 the armoured cable length does not exceed a total length of 10 m (33 ft);
 - (a) for longer cables, the 10 m (33 ft) free-air length is to be located at the motor end,
 - .4 the cable is supported on 300 mm (12 in) centers without sags or dips,
 - (a) do not use plastic tie-wraps to secure cable.
 - .5 where the cable passes through the wall of air handling units,
 - (a) provide a 100 mm (4 in) long section of rigid conduit (sleeve) through the wall,
 - (b) the sleeve is provided with escutcheons to seal the wall opening,
 - (c) the ends of the conduit are reamed and cleaned of burrs and sharp edges, and
 - (d) the cable/sleeve is sealed with a non-hardening mastic (i.e. firestop compound) at one end.
- .4 Terminate the shield on VFD inverter duty cables as follows:
 - .1 terminate at both ends of the cable at the motor enclosure box ground screw and at the VFD cabinet entrance potential bond screw,
 - .2 connect the shield to the ground screw of any intervening devices between the VFD and the motor where the cable is interrupted, including disconnect switches, output load-filters,
 - .3 connect the ends of the shield with a low-impedance 360° contact termination kit, either by use of a special-purpose gland or by a special-purpose bonding strap.
- .5 Terminate the three ground conductors at each end. A pig-tail may be used for final termination to the motor ground lug or the VFD ground lug provided the pig-tail size is not less than the size of the individual cable ground wire.

3.5 Harmonic Filter Control Power

- .1 Provide 120 VAC power supply to passive harmonic filters installed for VFDs. Run power supply to VFD designated control relay (for low- or no-power control), and then to the harmonic filter capacitor contactor.

3.6 Installation of Instrumentation, Communications and Control Cabling

- .1 Install wiring in conduit.
- .2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.

- .3 Run instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal and wire numbers on the As-built drawings.
- .4 Terminate control cables in equipment with suitable connectors.
- .5 Clearly identify cables/conductors at both ends, with permanent wire markers, indicating device/panel identification and terminal numbers on the device/panel (refer to standard detail 20 15 12-021 at the end of this specification section):
 - .1 Use applicable reference name or ID tag for the device or control panel.
 - .2 Print the labels such that the applicable panel/device identification is closest to the end of the cable.
 - .3 Where individual wires are run in conduit, collect wires associated to the same control panel/device and apply a label to the group of wires inside each control panel/device. Where there is insufficient space inside a device (such as a transmitter), the label may be applied to the conduit at the point of connection to the device.
 - .4 Where there are multiple conductors, individually identify each wire by its termination reference on the panel or device to which it connects.
 - .5 Where there are only two wires and it is readily understood where each wire is to be terminated (i.e. white neutral, green ground), individually marking of the wires is not required.

3.7 Installation of Fire Rated Cable

- .1 Provide fire rated cables for power and control wiring for fans, dampers, terminal units, control devices such as limit switches, etc., and other applicable equipment in the following systems:
 - .1 fans and dampers for smoke control systems, including areas of refuge,
 - .2 fans and dampers for smoke venting systems (as an aid to firefighting),
 - .3 smoke dampers, motorized fire dampers and combination smoke dampers that are required to function as part of a smoke control system (see specification section 25 55 13 for applicable dampers),
- .2 Exceptions: fire rated cables are not required under the following conditions;
 - .1 between an MCC, MPP or other power distribution panel, and the motor controller, VFD or damper actuator, if both the power source panel and the controller/VFD or actuator are in the same room or space,
 - .2 between a motor controller or VFD, and the motor served if both the controller/VFD and the motor are in the same room or space,
 - .3 between a motor controller or VFD, and a damper associated with the controlled motor, if the motor controller/VFD and the damper are located in the same room or space,
 - .4 between a BAS controller and the controlled equipment if both are located in the same room or space,
- .3 Select the type of fire rated cable for power and control wiring as follows:

Application	Mineral Insulated	Ceramifiable Insulation
Motor feeders	Yes	N/A

Dampers	Yes	Yes
BAS MSTP wiring	Yes	Yes
BAS Ethernet wiring	N/A	Yes

- .4 Handle cables with care to avoid cable kinks; it is recommended that cable be uncoiled from supply reel by rolling. Do not install kinked cables.
- .5 Install fire rated cables in accordance with ULC S139 and with the manufacturer's written instructions.
- .6 Install ceramifiable fire rated cable in conduit. Use conduit, fittings and supports in strict conformance with the cable manufacturer's installation instructions and product certification listing. Use of any other type of conduit, fasteners and support systems are not permitted.
- .7 Install cables on hangers or on channels secured to walls, beams or floor slabs, using clamps supplied by or recommended by the manufacturer.
- .8 Support cables with clamps, straps, clips of:
 - .1 copper,
 - .2 stainless steel,
 - .3 steel material,
- .9 Secure cables so that they cannot contact any dissimilar metals other than the approved supporting materials.
- .10 In damp or wet areas, wrap cables with electrical tape where the cable contacts the supporting materials unless the supporting materials are copper or stainless steel.
- .11 Support fire rated cables directly from fire rated structure in accordance with its listing requirements, at spacings as required by the manufacturer installation requirements.
- .12 Bend cables using a suitable hickey with a bending radius of not less than six times the cable diameter, unless the cable manufacturer instructions specify smaller turning radius.
- .13 Terminate cables using glands and seals as supplied by the cable manufacturer. Install gland and seal assemblies using tools specifically designed for the purpose.
- .14 Upon completion of cable terminations and prior to energization, test the insulation resistance of each cable with an insulation tester. Where measured values are not acceptable to the Consultant, rework or replace the cable until satisfactory results are obtained.
- .15 Provide the services of the cable manufacturer field service representative to inspect the cable installation and termination methods and provide a written report documenting that the cables have been installed in accordance with the requirements of the ULC standard and the ULC listing and in accordance with the manufacturer's recommendations. Submit the report to the Consultant.]

3.8 Grounding

- .1 Ground electrical equipment and wiring in accordance with the applicable electrical safety code and regulations applicable at the location of the Work except where greater requirements are specified herein.
- .2 Provide insulated green bonding conductor in each power and control conduit sized per Table 16 of the Electrical Safety Code. Minimum bonding conductor size #12AWG copper.
- .3 Install grounding conductors, outside electrical rooms and electrical closets, in conduit.

- .4 Make connections to neutral and equipment with brass, copper or bronze bolts, star-washers, and connectors.
- .5 Except for VFD Inverter Duty cables, ground all motors with separate green insulated copper ground conductor installed in power feeder conduit, wired from ground terminal in the motor controller to a ground lug bolted directly to the motor frame, located inside the motor terminal box. Size the ground conductor per Table 16 of the electrical safety code except that the smallest conductor size to be #12 AWG.
- .6 Ground VFD inverter duty cables using all three integral ground conductors, from the ground terminal in the VFD enclosure to the ground lug bolted directly to motor frame inside the motor terminal box.
- .7 For VFDs, bond both ends of the VFD inverter duty cable as previously specified herein.

3.9 Disconnect Switches

- .1 For indoor disconnect switches of Type 1 with sprinkler shield, 3R, 4 or 12, provide watertight conduit connections.
- .2 For outdoor disconnect switches, provide watertight connectors complete with O rings for conduit connections.
- .3 Provide disconnect switches for motor driven equipment provided under the mechanical trades work;
 - .1 locate the disconnect switches as follows;
 - (a) within 9 m (29 ft) and in the line-of-site of motors serving non-refrigeration motorized equipment, and within 9 m (29 ft) of the motor controller or VFD controlling the equipment,
 - (b) within 3 m (9.5 ft) and in the line-of-site of equipment containing refrigeration compressors and related motorized equipment that forms part of a refrigerant circuit,
 - (c) at cooling towers and other outdoor equipment where the motor controller is located indoors.
 - .2 disconnect switch types:
 - (a) fused type for motor controllers and VFD's,
 - (b) fused type for motorized packaged equipment.
 - (c) unfused type for cooling towers and other outdoor equipment where the motor controller is located indoors.
 - .3 Exception: a separate disconnect switch is not required where;
 - (a) a motor controller or VFD is provided with an integral disconnect switch with overcurrent protection and is located with respect to the controlled equipment as specified above, or
 - (b) packaged equipment is provided with an integral disconnect switch with overcurrent protection.
 - .4 Disconnect switches on load side of VFD:
 - (a) where a disconnect switch is required between a VFD and the driven motor due to excess distance or lack of line-of-site requirements, provide an unfused disconnect switch with integral disconnect status position switch, as close as possible to the motor,
 - (b) wire the status switch back to the VFD input for drive output protection.
- .1 Disconnect switches for packaged equipment:
 - .1 Provide fused disconnect switches for packaged equipment with integral motor controllers which have a nameplate SCCR rating less than • kA RMS symmetrical, even if the equipment already has integral disconnecting means and overcurrent protection.
- .2 Non-motorized equipment:

- .1 Provide unfused disconnect switch for the following equipment provided under the mechanical trades work.
 - (a) terminal unit boxes,
 - (b) reheat coils,
- .2 Locate disconnect switch immediately adjacent to equipment served.
 - (a) exception: for terminal unit boxes, a separate unfused disconnect switch is not required where a fused disconnect switch is provided as part of the terminal unit box control panel.
- .3 Where fuse protection is specified, install fuses of the correct rating in fused disconnect switches,
- .4 Where fuse protection is specified, provide a set of six spare fuses of each size used in the disconnect switches. Turn spare fuses over to the Owner and submit a copy of the receipt signed by the Owner.

3.10 Outlet Boxes

- .1 Size boxes in accordance with CSA C22.1. Use 102 mm (4") square or larger outlet boxes as required for special devices.
- .2 Gang boxes where wiring devices are grouped. Use combination boxes with barriers where outlets for more than one system are grouped.
- .3 Provide blank cover plates for boxes without wiring devices.

3.11 Service Lights, Switches and Receptacle

- .1 Provide service light in the following locations, with the type and spacing as indicated.

Location	Condition	Fixture Type	Fixture Spacing
Inside air handling units with walk-in access	Unit height ≤ 2.0 m (6.5 ft)	Marine	Each accessible section of the unit
	Unit height > 2.0 m (6.5 ft)	Area	
Inside air plenums	Plenum height Between 1.2 m and ≤ 2.0 m (6.5 ft)	Marine	Each 3.0 m (10 ft) in length or width
	Plenum height > 2.0 m (6.5 ft)	Area	
Outside of cooling towers (if shown on drawings).	All	Marine	At lower access door, and at top of ladder accessing the top deck.
Under service catwalks in mechanical rooms (if shown on drawings)	All	Area	As shown.
Other location as shown on drawings	All	As shown	As shown.

- .2 Mount switches for service lights in accessible location on the outside of plenums and air handling units. Provide one switch for each AHU system.
- .3 Provide one receptacle wired ahead of each service light switch, located between 300 mm (12 in) and 1200 mm (4 ft) above the floor.

3.12 Rooftop Maintenance Receptacles

- .1 Provide maintenance receptacles on roofs where mechanical trades work equipment is installed;
 - .1 locate an outlet within 7.5 m (24 ft) of each piece of rooftop HVAC equipment, except standalone fans that use a remote motor controller,
 - .2 one outlet may serve multiple equipment provided the distance limitation is met,
 - .3 all outlets may be connected to the same circuit,
 - .4 install each outlet at least 750 mm (20 in.) above the finished roof,
- .2 Support receptacles as follows;
 - .1 on a building wall,
 - .2 on the exterior side of the mechanical trade's equipment provided it does not impede maintenance access to the equipment and the equipment manufacturers written instructions permit its installation,
 - .3 as part of a manufacturer maintenance receptacle pedestal unit.
- .3 Where a manufactured maintenance receptacle pedestal is used;
 - .1 fasten the pedestal to the roof in accordance with the manufacturer instructions, including provision of any miscellaneous under-deck framing steel required,
 - .2 for field installed wiring, run No. 12 AWG building wire in liquid-tight flexible metallic conduit inside of the maintenance receptacle pedestal,
- .4 Where receptacles are mounted on building walls or mechanical trades equipment,
 - .1 provide 120 V, 20 A duplex receptacle, CSA configuration 5-20R, with an in-use weatherproof outlet cover,
 - .2 provide a weatherproof roof sleeve for conduit penetrations through the roof, located not more than 500 mm (20 in.) from the receptacle.
 - .3 use liquid-tight flexible metallic conduit between the roof penetration and the receptacle.
- .5 Arrange and pay for roofing work required, including roof openings, waterproof membrane modification and repair, roof-flashing and counter-flashing. Retain the services of the original roofing contractor to perform this work where a roof warranty is still in effect.
- .6 Where conduit is to be run on the roof to connect multiple maintenance receptacles,
 - .1 run wiring in PVC coated galvanized rigid conduit,
 - .2 support conduit on a galvanized steel framing system supported on the roof, with horizontal conduit located at least 600 mm (24 in.) above the roof,
 - .3 liquid-tight flexible metallic conduit may be used at final connection ends, but is limited to a length of 500 mm (20 in.).]

3.13 Seismic Restraint

- .1 Provide seismic restraints for electrical conduit in accordance with specification section 20 05 49.]

3.14 Coordination and Division of Responsibility – Division 20 and Division 26

- .1 Schedule A at the end of this Specification section specifies the division of responsibility between Division 20 and Division 26 for provision of electrical work for mechanical equipment, including termination of conductors.
- .2 For clarity;

- .1 the Division 20 electrical Work may be performed by the Division 26 contractor, but the work is managed and paid for by the Division 20 contractor.
- .2 related work performed under Division 26 is listed in Schedule A for reference.
- .3 Coordinate power requirements for mechanical trades equipment with the contractor under Division 26 of the work, including;
 - .1 provide a list of all planned and ordered mechanical trades equipment with motor horsepower ratings and electrical power requirements, prior to the Division 26 contractor procuring their power distribution equipment,
 - .2 periodically update this power requirements list as mechanical trades equipment is ordered, and review with the Division 26 contractor to allow them to revise breaker ratings in a timely manner,
- .4 Where the branch circuit breaker rating requirements change as a result of the actual ordered mechanical trades equipment, coordinate and pay for any breaker and feeder changes required whether the affected work is in Division 20 or Division 26 scope of work.

3.15 Wiring Diagrams

- .1 The following wiring diagrams are included at the end of this section:
 - .1 20 05 12 - 001 Mechanical – Electrical Coordination (Sheet 1 of 3)
 - .2 20 05 12 - 002 Mechanical – Electrical Coordination (Sheet 2 of 3)
 - .3 20 05 12 - 003 Mechanical – Electrical Coordination (Sheet 3 of 3)
 - .4 20 05 12 - 004 Variable Frequency Drives Single Line Schematic
 - .5 20 05 12 - 005 Rooftop Custom A.H.U. – Maintenance Receptacles
 - .6 20 05 12 - 006 Rooftop HVAC Equipment – Maintenance Receptacles

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
All	Motor Control Centers, motor controller racks, motor controllers, VFDs, Mechanical Breaker Panels (MBP), and disconnect switches	●	
General Mechanical Equipment fed from Dedicated Power Panels for Mechanical Equipment (Note 1)	Mechanical Service Panels (MSP), including branch overcurrent protection devices.		●
	Power wiring from MSPs and/or MCCs to: <ul style="list-style-type: none"> - motors, including between motors and motor controllers, VFDs and/or disconnect switches as applicable, - packaged equipment, including disconnect switches as applicable, - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.) 	●	
	Power wiring from RP and/or MBP to: <ul style="list-style-type: none"> - motors, including between motors and motor controllers, - packaged equipment, including disconnect switches as applicable, - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.) 	●	
General Mechanical Equipment fed from Non-dedicated Power Panels (Note 2)	Non-dedicated Power Panels (PP) and receptacle panels (RP), including branch overcurrent protection devices.		●
	Distribution splitters		●
	Power wiring from PPs and/or distribution splitters to: <ul style="list-style-type: none"> - motor controller, - disconnect switch ahead of VFD, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch) - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.) 		●
	Power wiring from RP to: <ul style="list-style-type: none"> - motor controller or disconnect switch, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch), - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.) 		●
	Power wiring from: <ul style="list-style-type: none"> - disconnect switch to a VFD, - motor controller or VFD to the motor, - disconnect switch to packaged equipment 	●	
Terminal Units BAS Controllers	Power wiring for controllers at 120 V, single phase terminating each terminal box controller		●
	Power wiring for controllers at 120 or 24 VAC, from junction box provided by Division 26 to each terminal unit controller.	●	























Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
	Power wiring for controllers at 24 VAC/DC, from building automation system control panels to terminal unit box controller.	●	
	3 phase, 208 V and higher voltage wiring direct to terminal unit box.		●
BAS Controls and OEM Controls	In service rooms: provision of 120/208 VAC mechanical service panels (MSP) complete with 15 A breakers in service rooms for use by Division 20 to 25.		●
	In service rooms: where MCC's are used, dedicated 120 VAC mechanical breaker panels (BP) complete with 15 A breakers for use by Division 20 to 25.	●	
	Power wiring for controls in service rooms: wiring from MSP or BP to the BAS and OEM control equipment.	●	
	Other than service rooms: Dedicated 120V 15A normal and emergency branch circuit breakers as indicated on the receptacle panel schedules.		●
	Power wiring for controls other than in service rooms: wiring from dedicated circuits in receptacle panels to control equipment.	●	
	120 V, single phase power supply with a junction box at specific control devices as shown.		●
	Breaker tamper-protection locks.	●	
	Instrumentation and actuator power and control wiring, for both BAS controls and OEM controls.	●	
	Control wiring to interlock motor controllers and to connect safety and operating controls.	●	
Plumbing Fixtures	120 V, single phase power supply with a junction box with sufficient wiring to terminate at plumbing fixtures requiring control power		●
	Conduit from adjacent junction box or pull box to plumbing fixtures requiring control power, pulling of wiring to the plumbing fixture and termination of wiring to the fixture or primary side of control transformer.	●	
	Control transformers and extra-low voltage wiring	●	
Medical Gas Equipment	Dedicated emergency power circuits 120 VAC, single phase for central and distributed medical gas alarm panels, terminated in the control panels.		●
	Control wiring between field installed instrumentation and medical gas alarm panels.	●	
Equipment Service Lights	120 VAC, 15A power circuits for equipment service lights, terminated in the equipment service light.		●
	120 VAC, 15A power circuits for equipment convenience receptacles, terminated in the receptacle.		●

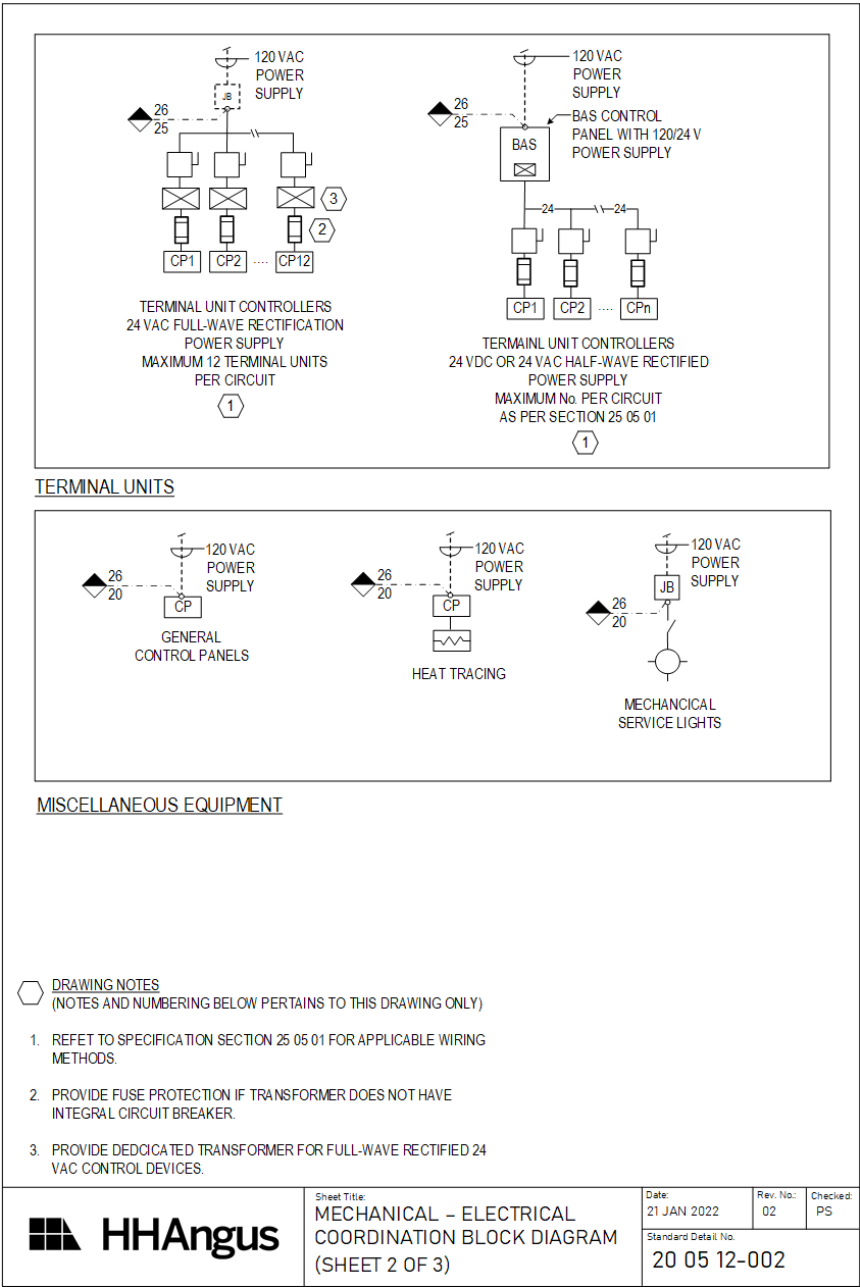
Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
	Power wiring from adjacent junction boxes to light switches/service convenience receptacles and fixtures	●	
	Equipment service lights, switches and convenience receptacles.	●	
Fire and Smoke Dampers	Power wiring to damper interlock control panels for smoke dampers, motorized fire dampers, and combination smoke/fire dampers.		●
	Wiring between damper interlock control panels (for smoke dampers, motorized fire dampers, and combination smoke/fire dampers), to their associated dampers.	●	
Life Safety Interface	Fire Alarm System (“FAS”) control and monitoring modules located at BAS control interface panel.		●
	FAS control and monitoring modules located at/near sprinkler and standpipe supervised valves and flow switches including wiring between each module and the respective valve/flow switch.		●
	Wiring between FAS control and monitoring modules, and smoke control and smoke venting fans and dampers.		●
	Termination of FAS control and monitoring wiring in BAS panels	●	
Rooftop Maintenance Receptacles	Rooftop maintenance receptacle pedestals.	●	
	Power wiring from breaker panel (BP) to and terminating in the rooftop maintenance receptacles.		●

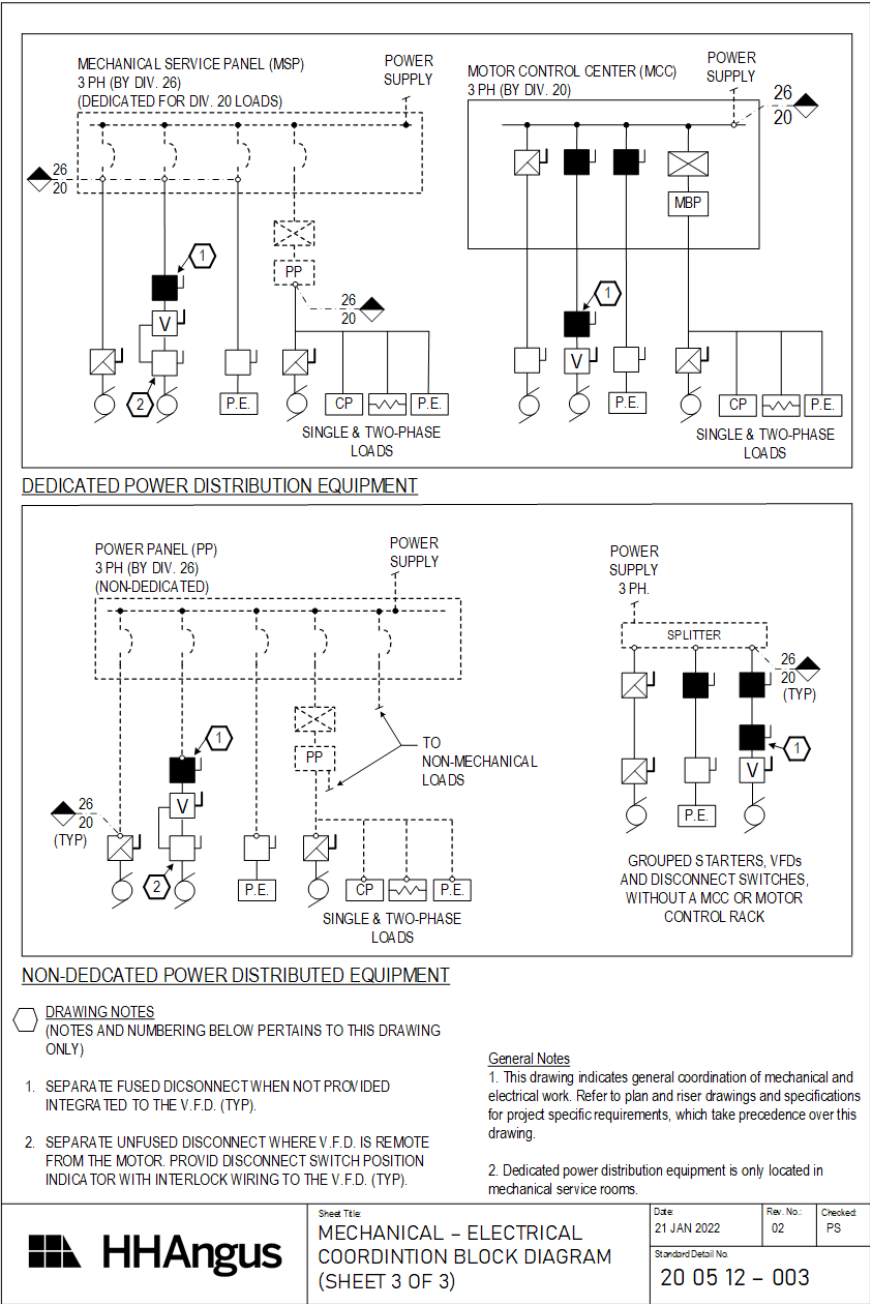
Notes:

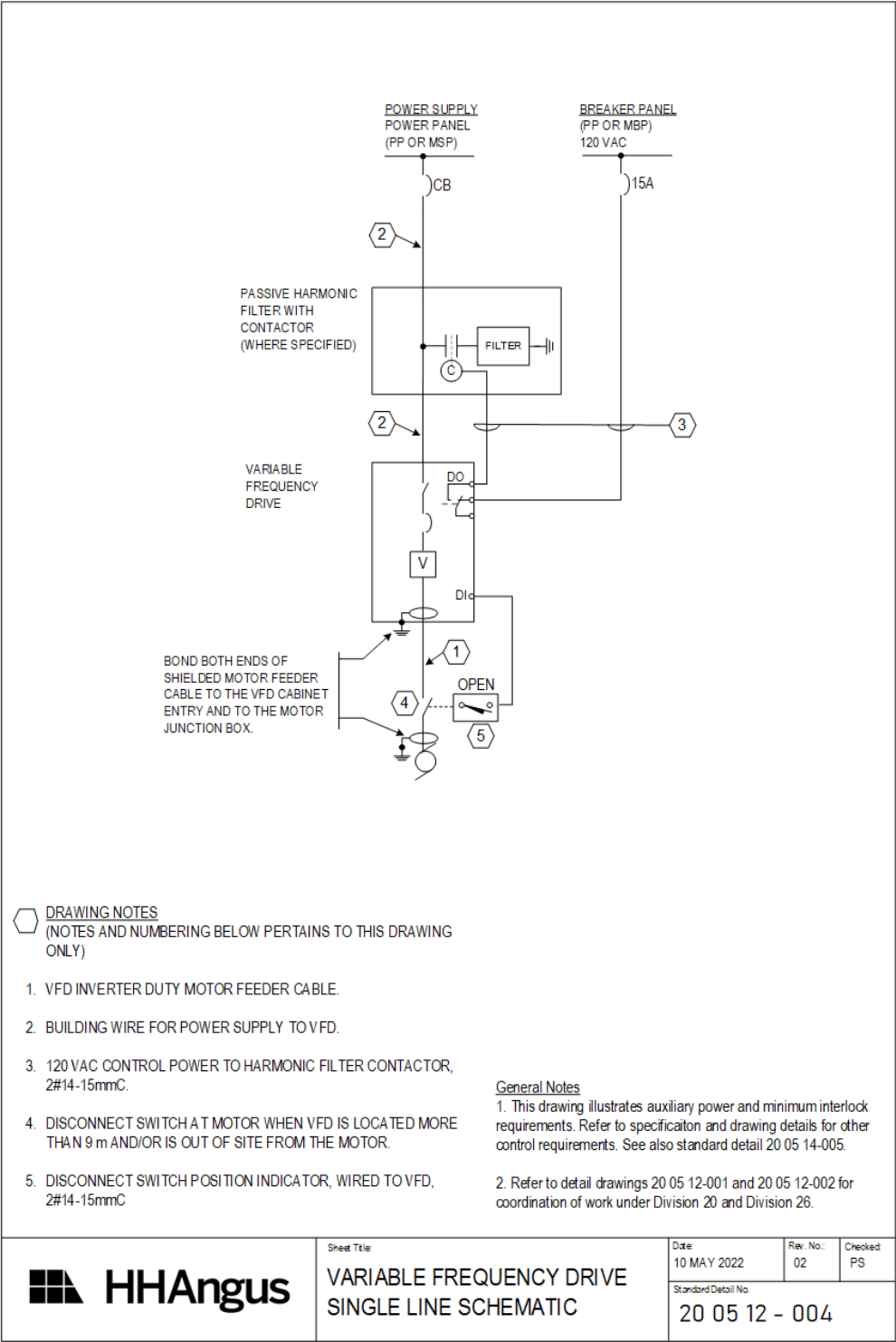
[1] MPP and MBP will be located in mechanical services rooms.

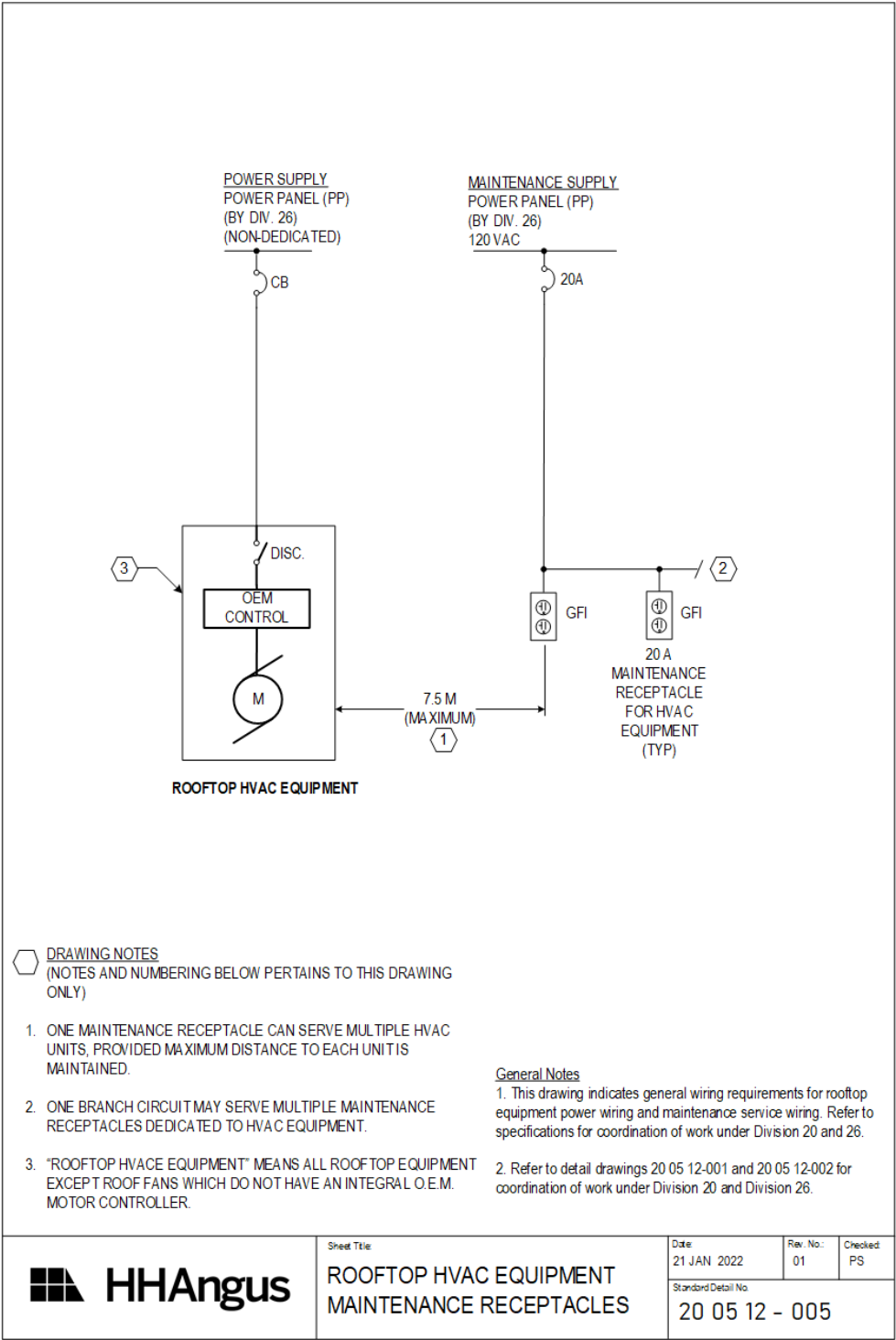
[2] PP and RP are not dedicated for mechanical equipment and may be located in any type of service room or space.

LEGEND			
	CONSTANT SPEED MOTOR CONTROLLER		SCOPE OF WORK: DIVISION "A" / DIVISION "B" BOUNDARY
	VARIABLE FREQUENCY DRIVE		WIRING AND/OR EQUIPMENT BY DIVISIONS 20-25
	UNFUSED SERVICE DISCONNECT SWITCH		WIRING AND/OR EQUIPMENT BY DIVISION 26
	FUSED SERVICE DISCONNECT SWITCH		
	TRANSFORMER		
	120/208 VAC MECHANICAL BREAKER PANEL		
	MECHANICAL SERVICE PANEL (DIV 26)		
	POWER PANEL (DIV 26)		
	JUNCTION BOX		
	MOTOR		
	ELECTRIC HEAT TRACING		
	PACKAGED EQUIPMENT WITH MOTORS AND INTEGRAL MOTOR CONTROLLERS		
	CONTROL PANELS, TERMINAL UNIT CONTROLLERS, AND OTHER NON-MOTORIZED EQUIPMENT		
	FUSE		
	LIGHT SWITCH (FOR SERVICE LIGHTS) - FLOOR PLAN		
	POWER SWITCH (SINGLE-LINE)		
	SERVICE LIGHT		
	ALARM BEACON		
<p><u>General Notes</u> 1. This drawing indicates general coordination of mechanical and electrical work. Refer to plan and riser drawings and specifications for project specific requirements, which take precedence over this drawing.</p>			
	Sheet Title: MECHANICAL – ELECTRICAL COORDINATION BLOCK DIAGRAM (SHEET 1 OF 3)	Date: 21 JAN 2022	Rev. No.: 02
		Checked: PS	Standard Detail No. 20 05 12 - 001









Issued For Tender 2023-12-18

THIS PAGE INTENTIONALLY LEFT BLANK

COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

20 05 13

1 GENERAL

1.1 Scope

- .1 Provide single phase and three-phase low-voltage AC induction motors from fractional horsepower to 200 horsepower, and brushless DC ECM motors.
- .2 This specification section applies to general purpose motors and inverter duty motors, except where otherwise specified by other specification sections of Divisions 20 to 25.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 14.13 Motor Controllers
 - .2 20 05 14.16 Variable- Frequency Drives

1.3 Definitions

- .1 The following definitions apply to this section and referenced sections:
 - .1 **ECM**: electrically commutated motor (AC supply, brushless DC motor).
 - .2 **ODP**: open drip proof (motor enclosure).
 - .3 **Soft-start motor controller**: a solid-state electronic motor controller that regulates output current and voltage during motor starting.
 - .4 **FEFC**: totally enclosed non-ventilated (motor enclosure without motor driven cooling fan).
 - .5 **TEFC**: totally enclosed fan cooled (motor enclosure with motor driven cooling fan).

1.4 Applicable Codes and Standards

- .1 Legislation:
 - .1 [O.Reg. 509/18 Energy and Water Efficiency – Appliances and Products
 - .2 U.S. DOE 10 CFR 431 Code of Federal Regulations Part 431 (to the extent adopted in O.Reg. 509/18)]
- .2 Product standards:
 - .1 CSA C22.2 No. 100 Motors and Generators
 - .2 CSA C390-10 Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-phase Induction Motors
 - .3 CSA C747-09 Energy Efficiency Test Method for Small Motors
 - .4 IEEE 85-1973 Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery
 - .5 IEEE 112-2004 Standard Test Procedure for Polyphase Induction Motors and Generators
 - .6 IEEE 114-2010 Standard Test Procedure for Single-Phase Induction Motors
 - .7 NEMA MG1-2016 Motors and Generators

1.5 Submittals

- .1 Submit manufacturer data sheets with the following information for motors 50 HP and smaller:
 - .1 motor model/catalogue numbers,
 - .2 motor full load ratings: current, speed, voltage, horsepower, efficiency, and KVAR.
- .2 Submit manufacturer data sheets with the following information for motors greater than 50 HP:
 - .1 associated driven equipment identification tag,
 - .2 motor model/catalogue numbers,
 - .3 motor full load ratings: current, speed, voltage, horsepower, efficiency, and KVAR,
 - .4 bearing data,
 - .5 acceleration time at maximum inertia,
 - .6 guaranteed efficiency and power factor at full load, 75% load, 50% load, and 25% load,
 - .7 dBA scale sound power levels.
- .3 For inverter duty motors 5 HP and larger, submit manufacturer data sheets or similar documentation for the following information:
 - .1 confirmation of compliance to NEMA MG-1 for inverter duty,
 - .2 protection method for grounding of stray motor currents,
 - .3 motor frequency operating range (minimum to maximum),
 - .4 insulation winding class,
 - .5 details of motor bearing construction.

1.6 Shipping and Storage

- .1 Ship motors from factory;
 - .1 packed in impact-absorbing material, or fastened to hardwood skid or pallet for fork truck handling. Do not use Styrofoam or similar plastic-based materials,
 - .2 protected against dirt and moisture during transit and outdoor storage,
 - .3 clearly identified with permanent ink marking on packing,
- .2 Protect motors attached to equipment against dirt and moisture during transit and outdoor storage.

1.7 Operating and Maintenance Manuals

- .1 Include in the operating and maintenance manuals the following data for all motors supplied to the project:
 - .1 shop drawing data as specified herein,
 - .2 motor weight,
 - .3 sliding base dimensioned drawings,
 - .4 internal winding connection diagram,
 - .5 speed torque performance data for across line start, from stand-still to synchronous speed,
 - .6 installation and maintenance instructions.

2 PRODUCTS

2.1 Motors - General Requirements

- .1 Listed to CSA C22.2 No.100.
- .2 Listed to CSA C390 for NEMA MG-1 Premium efficiency ratings (three phase, 1 – 200 HP)
- .3 Motors selected and marked with a power rating that is the greater of:
 - .1 not less than the input brake horsepower of driven equipment at both the specified operating condition and at maximum run-out conditions at design driven equipment operating speed, without operation in the motor service factor, and
 - .2 not less than the minimum horsepower rating as shown.
- .4 Common motor characteristics:
 - .1 frequency: 60 Hz.
 - .2 voltage:
 - (a) 115 and 220 volt, for single phase motors as shown,
 - (b) 208 volt, for three phase motors, as shown.
 - .3 nominal rated-load speed: 1750 RPM unless otherwise shown,
 - .4 minimum ambient operating temperature at nameplate power rating: 40°C (104°F),
 - .5 vibration velocity: not to exceed 2.0 mm/s (0.08 inches/second) measured at bearing housing,
 - .6 motor generated noise, 10 HP and larger: not to exceed 85 dBA, measured at 3 m (10 ft) in accordance with IEEE 85.
- .5 Permanently lubricated ball bearing rotor supports.
- .6 Motor enclosure:
 - .1 cast iron, aluminum, or rolled steel construction,
 - .2 drain openings,
 - .3 shouldered lifting eye bolts (three phase TEFC motors),
 - .4 bi-directional, spark-proof, abrasion and corrosive resistant cooling fan keyed to shaft (three phase TEFC motors),
 - .5 compression type grounding lug or double ended cap screw of silicon bronze, mounted in conduit box by drilling and tapping into motor frame.
- .7 Motor nameplate:
 - .1 stainless steel plate mounted on enclosure with stainless steel fastening pins,
 - .2 information as described in NEMA MG-1 including motor efficiency rating,
 - .3 motor bearing part numbers and motor wiring diagram instructions,
- .8 Protective coating, TEFC motors:
 - .1 primer and 4 to 5 mils epoxy overcoat on external surfaces, and corrosion resistant coating of epoxy paint on internal surfaces, shaft, rotor, stator iron, and end bells,
 - .2 shaft extension protected with rust preventive strippable coating capable of being peeled off or unwrapped.
- .9 Motor termination junction boxes and motor leads:

- .1 cast iron or sheet steel diagonally split, tapped for conduit, and attached to motor frame with cadmium plated hex head cap screws,
- .2 arranged for conduit entry from either side or bottom,
- .3 gaskets between box and motor frame and between halves of box, with cover secured with cadmium plated hex head cap screws,
- .4 motor leads in conduit box;
 - (a) identified in accordance with ANSI C6.1,
 - (b) with the same insulation class as windings,
 - (c) sized in accordance with EASA recommended minimum ampacity values,
- .5 motor leads between motor frame and termination box to pass through tight fitting neoprene rubber seals.

2.2 Motor Efficiency

- .1 Motor efficiency test method:
 - .1 CSA C747 or IEEE 114 for single phase ECM and AC motors,
 - .2 CSA C747 or IEEE 112 for polyphaser motors up to 3 HP, and.
 - .3 CSA C390 or IEEE 112 for three-phase motors 1 to 200 HP.
- .2 Motor efficiency ratings:
 - .1 Minimum motor efficiency to be not less than the greater of the following:
 - (a) applicable legislation for energy efficiency,
 - (b) NEMA Premium® for three-phase integral horsepower motors, and
 - (c) as specified in the Schedules appended at the end of this specification section.
- .3 These motor efficiency ratings do not apply to electric motor-driven fire pumps.

2.3 Single Phase Motors

- .1 Single phase motor rating less than 375 W (1/2 hp):
- .2 Types:
 - .1 PSC motor:
 - (a) permanent split capacitor type for AC power supply,
 - (b) suitable for variable speed applications.
- .3 ECM motor:
 - .1 brushless DC electrically commutated motor with integral microprocessor based inverter and controller, for AC power supply,
 - .2 factory programmed or field programmable for specific application,
 - .3 capable of accepting an external 0-20 mA or 0-10 V signal for remote variable speed operation including fan On/Off control.
- .4 Winding insulation: Class B.
- .5 Suitable for mounting in the horizontal or vertical orientation.
- .6 Continuous duty rating with 1.35 service factor.
- .7 ODP or TEFC enclosure, resilient mounts.

- .8 Built-in overload protection.
- .9 Motor over-temperature protection as specified herein.

2.4 Three Phase Motors, Fractional Horsepower

- .1 Motors of 375 W (½ HP) and 560 W (¾ HP).
- .2 For use with magnetic motor controllers.
- .3 Three phase squirrel cage induction type, NEMA T frame, general purpose type, to NEMA MG-1.
- .4 NEMA B design.
- .5 Winding insulation: Class F, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load,
- .6 Continuous duty rating with minimum 1.15 service factor.
- .7 ODP or TENV enclosure.
- .8 Motor over-temperature protection as specified herein.

2.5 Three Phase Motors, Integral Horsepower

- .1 Motors 745 W (1 hp) to 150 kW (200 hp).
- .2 For use with constant speed magnetic motor controllers.
- .3 Three phase squirrel cage induction type, NEMA T frame, general purpose type.
- .4 NEMA design:
 - .1 Type B for centrifugal fans and pumps,
 - .2 Type C for positive displacement pumps and compressors.
- .5 Winding insulation: Class F, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load,
- .6 Continuous duty rating with minimum 1.15 service factor.
- .7 TEFC enclosure.
- .8 Suitable for horizontal, vertical or belt-driven mounting.
- .9 Motor over-temperature protection as specified herein.
- .10 Motor winding leads:
 - .1 three (3) leads for single speed operation,
 - .2 six (6) leads for two-speed operation (five lead two-speed motors are not acceptable).

2.6 Three Phase Motors – Inverter Duty

- .1 Application: motors 745 W (1 hp) to 150 kW (200 hp) operating on power supply controlled by a variable frequency drive (inverter) motor controllers and soft-start constant speed motor controllers.
- .2 General requirements:
 - .1 three phase squirrel cage induction type, NEMA T frame, general purpose type, suitable for pulse width modulated wave form,
 - .2 winding insulation: Class F insulation, with a rated motor winding temperature rise of not more than 90°C above an ambient temperature of 40°C at full motor load (i.e. Class B temperature rise),
 - .3 continuous duty rating and rated for 200% of full load starting torque,

- .4 service factor: 1.15 on Sine Wave and 1.0 on pulse-width modulated power supply,
- .5 TEFC enclosure,
- .6 suitable for horizontal, vertical or belt-driven mounting,
- .7 motor over-temperature protection as specified herein,
- .8 motor winding leads: three (3) leads,
- .9 motor over-temperature protection as specified herein except where the protection function is provided by the variable frequency drive.

.3 Special requirements:

- .1 motors rated for inverter duty in accordance with NEMA MG-1 Part 31,
 - (a) stator winding insulation ratings:
 - i) peak voltage and partial discharge-free voltages:

Rated Voltage V RMS	Withstand Voltage Zero-to-Peak (Line-to-Line) V	Partial Discharge-Free Zero-to-Peak (Line-to-Line) V
208, 3 phase	645	513
575, 3 phase	1782	1281

- ii) for operation on a VFD with a carrier frequency of between 2 and 12 kHz.
 - iii) with a VFD switching voltage rise time of 0.1 μ s and higher.
- .2 speed range: minimum 10:1 (6 to 60 Hz) for variable torque applications,
- .3 provided with stray rotor current grounding system consisting of;
 - (a) 3 HP and smaller: electrically conductive bearing grease for motors,
 - (b) all HP ratings: rotor shaft grounding system at the drive-end bearing, either integral to the bearing construction or externally mounted to the motor frame.

Standard of Acceptance

- AEGIS - fig. SGR series
- .4 for motors 100 HP and larger, provide insulated bearings on the non-drive end.
- .5 motor to be compatible with type of soft-start motor controller or variable frequency drive supplied under other specification sections, and that the starter/motor system will be capable of providing rated torque over a frequency range from 15 to 60 hz while operating within motor temperature rise specification,
- .6 motor to be capable of operating between 60 Hz and 90 Hz with torque reducing at drive frequency above 60 Hz,
- .7 ball bearing rotor supports suitable for continuous low speed operation at minimum motor speed.
- .8 drive end face drilled and tapped (4 places) for mounting of auxiliary devices.
- .4 Motor stator winding:
 - .1 made up with copper magnet wire coated with moisture resistant triple-build Class F insulation, non-hygroscopic varnish, phase paper insulation, and with thermal rating of not less than 150°C for 30,000 hours life when tested in accordance with IEEE No. 57,

- .2 insulation resistance greater than 100 megohms when measured at 25°C with 1000-volt direct current mega-ohm bridge,
- .3 slot-wound installation, held in stator slots that have had sharp edges and burs removed prior to winding insertion,
- .4 connection leads mechanically secured and silver soldered,
- .5 designed for operation in either direction of rotation.
- .5 Motor bearings:
 - .1 anti-friction single shield, vacuum-degassed steel ball bearings,
 - .2 lubricated bearings; extended pipe zerk fitting, and ½-lb relief fitting for external lubrication while machine is in operation, bearing seal, lubricated at factory after assembly,
 - .3 bearing shield on motor winding side of bearing,
 - .4 rated fatigue life of L'-10 (B-10) 150,000 hours for direct coupled applications and 50,000 hours for belted applications,
 - .5 belt drive-set rating based on radial loads and pulley sizes from NEMA MG1-14.43.
- .6 Motor junction box sized and provided with at least two (2) conduit connection points, one for motor feeder cable and one for motor thermal sensor control wiring.

2.7 Motor Over-Temperature Protection

- .1 Motor thermal protection for single phase motors mounted in air ducts, plenum chambers or in air stream inside air handling equipment:
 - .1 motor winding thermostats, normally closed contact, phenolic snap-acting disc thermal switch, temperature calibrated,
 - .2 automatic reset type.

Standard of Acceptance

- ° Texas Instruments - Klixon Phenolic Motor Protectors

- .2 Motor thermal protection for three phase motors less than 37 kW (50 HP) that are mounted in air ducts, plenum chambers or in air stream inside air handling equipment:
 - .1 Winding sensors;
 - (a) three (3) Positive Temperature Coefficient (PTC) temperature sensors, one in each motor winding, wired in series, and compatible with Texas Instruments - Klixon model 42AA100E control unit,
 - (b) control unit provided under section 20 05 14.13 or 20 05 14.16.
- .3 Motor thermal protection for three phase motors 37 kW (50 HP) and larger:
 - .1 Winding sensors;
 - (a) three (3) Positive Temperature Coefficient (PTC) temperature sensors, one in each motor winding, wired in series, and compatible with Siemens model 3RN10 12 control unit,
 - (b) control unit provided under section 20 05 14.13 or 20 05 14.16.

2.8 Field Applied Rotor Grounding System for Operation with Variable Frequency Drives

- .1 Shaft-grounding ring system with contact brushes providing 360 degree coverage of drive shaft, to provide grounding of rotor to motor frame.

Standard of Acceptance

- ° AEGIS - fig. SGR series

2.9 Sliding Base for Motors with V-belt Drives

- .1 Construction:
 - .1 fabricated from steel as a single unit with double supported slide and two adjusting bolts,
 - .2 finished with coating as specified above for motor exterior.

3 EXECUTION

3.1 Application

- .1 Refer to other specification sections for motor style requirements for single phase motors and fractional horsepower polyphase phase motors (ODP, TENV or TEFC).
- .2 Where motors are provided with internal thermistors for motor overtemperature protection, run thermistor control wiring:
 - .1 in the same conduit as the motor power conductors for constant speed motor controllers,
 - .2 in a separate conduit from the motor power conductors for variable frequency drive motor controllers.

3.2 Field Applied Rotor Grounding System

- .1 Install shaft-grounding system on motors operating on variable speed drives and not provided with OEM rotor grounding systems.

3.3 Maintenance During Construction

- .1 Rotate motors by hand at one month intervals while at the project site.

3.4 Schedules

- .1 The following schedules of motor minimum electrical efficiency ratings apply:
 - .1 Schedule A – Single Phase Electric Motor Efficiency, 0.25 to 0.5 HP,
 - .2 Schedule B – Two-phase Electric Motor Efficiency 0.25 to 3 HP, and Three-phase Electric motor Efficiency 0.25 to 0.75 HP,
 - .3 Schedule C – Three Phase Electric Motor Efficiency, 1 to 200 HP.

Schedule A - Single Phase Electric Motor Efficiency, 0.25 to 0.5 HP

Motor HP (kW)	Single Phase, Permanent-Split Capacitor 0.25 to 0.5 HP Nominal Full-Load Efficiency (%) [Note 1]		
	Open Motors		
	6 Pole 1200 RPM	4 Pole 1800 RPM	2 Pole 3600 RPM
0.25 (0.18)	62.2	68.5	66.6
0.33 (0.25)	66.6	72.4	70.5
0.5 (0.37)	76.2	76.2	72.4

Notes:

[1] From U.S. DOE 10 CFR Part 431, SubPart X, §431.446(a)

Schedule B – Polyphase Electric Motor Efficiency, 0.25 to 3 HP

Motor HP (kW)	Polyphase Induction Motors 0.25 to 3 HP Nominal Full-Load Efficiency (%) [Note 2]			Remarks
	Open Motors			
	6 Pole	4 Pole	2 Pole	
0.25 (0.18)	67.5	69.5	65.6	2 Phase & 3 Phase
0.33 (0.25)	71.4	73.4	69.5	2 Phase & 3 Phase
0.5 (0.37)	75.3	78.2	73.4	2 Phase & 3 Phase
0.75 (0.55)	81.7	81.1	76.8	2 Phase & 3 Phase
1 (0.75)	82.5	83.5	77.0	2 Phase only
1.5 (1.1)	83.8	86.5	84.0	2 Phase only
2 (1.5)	---	86.5	85.5	2 Phase only
3(2.2)	---	86.9	85.5	2 Phase only

Notes:

[2] From U.S. DOE 10 CFR Part 431, SubPart X, §431.446(a)

Schedule C – Three-Phase Electric Motor Efficiency, NEMA Premium, 1 to 200 HP

Motor HP (kW)	Three-Phase Induction Motors 1 to 200 HP Nominal Full-Load NEMA Premium Efficiency (%) [Note 3]							
	2 Pole 3600 RPM		4 Pole 1800 RPM		6 Pole 1200 RPM		8 Pole 900 RPM	
	Encl.	Open	Encl.	Open	Encl.	Open	Encl.	Open
1 (0.75)	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5 (1.1)	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2 (1.5)	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3 (2.2)	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5 (3.7)	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5 (5.5)	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10 (7.5)	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15 (11)	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20 (15)	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25 (18.5)	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30 (22)	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40 (30)	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50 (37)	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60 (45)	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75 (55)	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100 (75)	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125 (90)	95.0	94.1	95.4	95.4	95.0	95.0	94.1	94.1
150 (110)	95.0	94.1	95.8	95.8	95.8	95.4	94.1	94.1
200 (150)	95.4	95.0	96.2	95.8	95.8	95.4	94.5	94.1

Notes:

[3] From U.S. DOE 10 CFR Part 431, SubPart B, §431.25(h), Table 5, and NEMA MG-1 Table 12-12.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

CONSTANT SPEED MOTOR CONTROLLERS 20 05 14.13

1 GENERAL

1.1 Scope

- .1 Provide constant speed motor controllers including magnetic, manual, reduced voltage and solid-state motor controllers, for electric motor-driven equipment provided under mechanical trades work.
- .2 Refer to specification section 20 05 14.16 for variable frequency drive motor controllers.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections;
 - .1 20 05 12 Wiring Requirements for Mechanical Services
 - .2 20 05 13 Common Motors Requirements for Mechanical Equipment
 - .3 20 05 49 Seismic Restraint
 - .4 20 05 53 Identification

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Constant speed motor controllers** – a motor controller/starter other than VFDs, for operating control of single speed, multi-speed, and/or reversing operation as specified, consisting of a disconnecting means, a short-circuit protection device, a motor-starter contactor, a motor overload protection device, and a control circuit.
 - .2 **SCCR**: the RMS symmetrical short-circuit current rating of the motor controller, measured at the output of the controller (short-circuit withstand rating has the same meaning).
- .2 For other definitions, refer to definitions in specification section 20 05 12.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 IEEE 315 Standard for Graphical Symbols for Electrical and Electronic Diagrams
 - .2 CSA C9 Dry-Type Transformers
 - .3 CSA C22.2 No. 5 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
 - .4 CSA C22.2 No. 14 Industrial Control Equipment
 - .5 CSA C22.2 No. 29 Panelboards and Enclosed Panelboards
 - .6 CSA C22.2 No. 39 Fuseholder Assemblies
 - .7 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-environmental Considerations
 - .8 CSA C22.2 No. 94.2 Enclosures for Electrical Equipment, Environmental Considerations
 - .9 CSA C22.2 No. 106 HRC – Miscellaneous Fuses
 - .10 CSA C22.2 No. 248.8 Low-voltage Fuses – Part 8: Class J Fuses
 - .11 CSA C22.2 No. 254 Motor Control Centres

1.5 Design Criteria

- .1 Device legend with list of abbreviations, general schematic wiring diagrams for single and three phase motor controllers, are included at the end of this Specification section. This material is to be used in interpretation of specification and equipment schedule requirements for motor controllers and accessories within motor controller enclosures, motor and wiring protection components, and ancillary devices.

1.6 Seismic Qualification

- .1 Seismically qualify (certify) motor controllers and MCCs to remain operational after being subjected to the design seismic forces assuming a building height factor (NBCC) $A_x = 3.0$ with equipment rigidly mounted, by the shaker table method in accordance with Specification section 20 05 49.

1.7 Submittals

- .1 Submit motor controller wiring diagrams that are specifically prepared for the project. The use of standard manufacturer wiring diagrams are permitted provided they clearly identify any included options that are required to meet these specifications.
- .2 Wiring diagrams format:
 - .1 ladder diagram form with energized conductor on the left and grounded conductor on the right,
 - .2 IEEE 315 graphic symbols with individual horizontal lines numbered sequentially and every conductor terminal matching identifying terminal numbers.
- .3 Submit MCC dimensioned layout drawings, indicating service clearances, and labelled showing all included motor controllers and disconnect switches as applicable.
- .4 Provide wiring diagrams for control circuits where control wiring extends beyond starter enclosure

2 PRODUCTS

2.1 General – Short Circuit Current Rating

- .1 Short circuit protection rating (SCCR) for motor controllers:
 - .1 motor controller minimum SCCR value: 25 kAIC RMS symmetrical,
 - .2 SCCR value to be marked on the motor controller nameplate. Where the SCCR nameplate rating references an instruction manual, provide a separate label that states the SCCR value.

2.2 Motor Controllers - General Requirements

- .1 General;
 - .1 These general requirements apply to all constant speed motor controllers unless otherwise specified.
 - .2 Motor controllers listed to CSA C22.2 No. 14.
 - .3 Size motor controllers for rated motor load and contactor coil load.
 - .4 Operating voltage: as shown on drawings.
 - .5 Engraved Lamacoid nameplate identifying load served.
 - .6 Supply motor controllers from one manufacturer.

Standard of Acceptance

- ABB
 - Allen Bradley
 - Baldor
 - Benshaw
 - Cutler Hammer
 - Graham (Danfoss)
 - Klockner Moeller
 - Siemens
 - Square D
 - Toshiba
 - WEG
 - Yaskawa
- .2 Electrical enclosure:
- .1 painted metal construction, hinged door with screwdriver-operated latches,
 - .2 conforming to CSA C22.2 No. 94.1 /UL 50E and of the following types unless otherwise specified herein or in other specification sections of mechanical trades work;
 - (a) indoor installation, general use: Type 1 or 12
 - (b) outdoor installation: Type 3R or 4.
 - .3 allow for additional space inside of enclosure to allow installation of motor current transducers/transmitters (provided under Division 25).
- .3 Disconnecting means:
- .1 interlocked to disconnect all input power to the motor controller, and lockable in the open position,
 - .2 door mounted or enclosure-flange mounted operating handle.
- .4 Overcurrent protection – Circuit Breakers:
- .1 magnetic-only, instantaneous-trip motor circuit protector type, to operate only when value of current reaches setting;
 - (a) adjustable trip settings on breakers to range from 3-8 times current rating,
 - (b) fixed instantaneous type to be minimum 8 times motor current rating,
 - .2 listed to CSA C22.2 No. 5,
 - .3 minimum interrupting rating: not less than the SCCR specified herein.
 - .4 common-trip breakers with single handle for multi-pole applications,
 - .5 accessories:
 - (a) on-off locking device,
 - (b) handle mechanism.
- .5 Overcurrent protection – fuses:
- .1 HRC current and energy limiting, type “J” time-delay, with NEMA Class “J” rejection type mountings,
 - .2 minimum interrupting capacity: 200 kAIC.

Standard of Acceptance

- Ferraz Shawmut - Amp-Trap 2000-AJT
- Littelfuse-JTD_ID Series
- Bussmann-LPJ-SPI

- .3 size fuses installed in motor controllers, or in disconnect switches used in conjunction with motor controllers, for branch circuits to the maximum value permitted for motor overcurrent protection in accordance with CSA C22. 1.
- .4 provide one spare set of three fuses for each rating and type of fuse used.
- .6 Contactor and motor overloads:
 - .1 NEMA magnetic contactor, with 120 VAC, 60 Hz control coil.
 - .2 integral or bolt-on overload relay with monitoring of each phase:
 - (a) solid state, adjustable setting,
 - (b) manual reset button,
 - (c) sized and set to suit characteristics of motor,
 - (d) Form C overload status contacts.
- .7 Control transformer:
 - .1 120 VAC with fused primary and secondary circuits, sized for starter requirements plus an additional 50 VA for remote damper or valve actuator.
- .8 Operating controls:
 - .1 door panel mounted, momentary push-buttons (Start-Stop) or three-position selector switch (Hand-Off-Auto) as shown,
 - .2 Hand-Off-Auto selector switches provided with additional contact block to allow remote monitoring when selector switch is in the Auto position.
- .9 Pilot lights:
 - .1 type: 120 VAC, push-to-test LED with lamp transformer,
 - .2 quantity: one cover mounted pilot light (green) to indicate motor running
- .10 Accessories:
 - .1 numbered terminal strips and function identification for field-connected control devices,
 - .2 auxiliary contacts and/or auxiliary relays to satisfy interlocking and automatic control requirements.
- .11 Control units for motor winding over-temperature sensors:
 - .1 control unit as specified herein, compatible with PTC sensors provided in applicable motors.

2.3 Single Phase Manual Motor Controllers

- .1 Single pole manual type with interchangeable and adjustable overload heaters.
- .2 Rating: motor rated up to ½ HP at 120 VAC and 1 hp at 240 VAC.
- .3 Enclosure:
 - .1 complete with mechanically fastened steel cover plate, pilot light and handle guard with standard junction box,
 - .2 flush-mounted in all indoor spaces except in mechanical service rooms, electrical service rooms, vehicle garages, or where the finished wall is poured concrete:
 - .3 surface mounted in mechanical service rooms, electrical service rooms, vehicle garages, or where the finished wall is poured concrete.
 - .4 surface mounted for outdoor installations.

2.4 Full-Voltage Magnetic Motor Controllers ("FVNR")

- .1 Type:
 - .1 full-voltage across-the-line combination motor starter and disconnect switch,
 - .2 for three phase motors, and for single phase motors requiring remote operating control,
 - .3 non-reversing, single speed operation.
- .2 For single phase motors;
 - .1 less control transformer for 120 V motors,
 - .2 single-pole, single phase motor contactors, or three-pole three-phase motor contactors with power wiring arranged to feed through all three contacts.

2.5 Motor Thermal (over-temperature) Protection

- .1 Single phase motors:
 - .1 Not applicable: thermal motor protection provided with motor under Section 20 05 13.
- .2 Three phase motors - less than 37 kW (50 HP):
 - .1 Application:
 - (a) constant speed motors less than 37 kW (50 HP) that are mounted in air ducts, plenum chambers or in air stream inside air handling equipment.
 - .2 Winding sensors:
 - (a) winding sensors provided in motors under Section 20 05 13.
 - .3 Control unit:
 - (a) compatible with three (3) Positive Temperature Coefficient ("PTC") temperature sensors, one in each motor winding, wired in series,
 - (b) electronic motor protection module, single channel, 3 sensors per channel,
 - (c) 120 VAC line power,
 - (d) manual reset.

Standard of Acceptance

- ° Texas Instruments - Klixon model 42AA100E

- .3 Three phase motors - 37 kW (50 HP) and larger:
 - .1 Application:
 - (a) constant speed motors 37 kW (50 HP) and larger.
 - .2 Winding sensors:
 - (a) winding sensors provided in motors under Section 20 05 13.
 - .3 Control unit:
 - (a) compatible with three (3) Positive Temperature Coefficient ("PTC") temperature sensors, one in each motor winding, wired in series,
 - (b) temperature monitoring relay, single channel, 3 sensors per channel,
 - (c) 120 VAC line power,
 - (d) unit holds relay contacts on power supply failure,
 - (e) automatic/manual reset, with remote reset.

Standard of Acceptance

- Siemens - 3RN2

- .4 Additional requirements for three phase motor thermal protection:
 - .1 control unit mounted inside motor controller enclosure,
 - .2 120 VAC power to control unit fed from motor controller,
 - .3 a momentary normally-closed Reset push-button located on front of starter enclosure door,
 - .4 test and test-reset push-buttons located on front of starter enclosure door,
 - .5 auxiliary output relay for safety interlock to motor contactor,
 - .6 red pilot light indicating high-winding temperature,
 - .7 1 N.O. contact for remote alarm monitoring.

3 EXECUTION

3.1 General Installation Requirements

- .1 Coordinate location of motor controllers with the trade contractors under Division 25 and 26, specifically but not exclusively for termination requirements for power and control wiring.

3.2 Motor Controller Selection and Installation

- .1 Except where equipment is otherwise specified or shown to be provided with a variable speed drive motor controller, provide constant-speed motor controllers of the applicable type listed in the following table, unless otherwise shown in other Specification sections.

Equipment Type	Phase	HHA Controller Diagram Type	Motor Controller Type HP Rating		
			FVNR, FVR, FVMS FVMS-R	RVSS	RVAT
			Motor HP	Motor HP	Motor HP
Pumps	1	L	≤ 0.5	---	---
	3	A, B	≤ 25	>10 and ≤ 50	> 50
Pumps, Duplex	3	C	≤ 25	>10 and ≤ 50	> 50
Fans	1	K, L, LF	≤ 0.5	---	---
	3	A, B, BF	≤ 50	≤ 50	> 50
Packaged Equipment	3	(Note 1)	≤ 50	≤ 50	> 50

Notes:

- (1) Control type as specified in separate equipment specification sections.
- .2 Where motor controllers are not located in an MCC, install motor controllers adjacent to controlled equipment or as otherwise shown. Position the motor controller so that:
 - .1 the door front is readily visible and accessible from the work space,
 - .2 for wall-hung motor controllers: with the top of the motor controls located between 1700 and 1800 mm above the local work surface and all adjacent motor controllers aligned to the same height,
 - .3 with a minimum clear space of 1000 mm (40 in.) in front of the motor controller.

- .3 Mount motor controllers to building walls or structure, on Unistrut or similar mounting rails; do not weld miscellaneous support steel to building structure. Secure with seismic-rated fasteners where seismic restraint is required in accordance with specification section 20 05 49.
- .4 Where there is no adjacent or insufficient wall space or building structure upon which to mount the motor controller, provide a floor-mounted fabricated support assembly to mount the motor controller. Design the support assembly to:
 - .1 support the dead-weight of the motor controller,
 - .2 withstand a 220 N (50 lbf) horizontal force from any direction applied to the starter enclosure, with a maximum deflection of 3 mm (1/8 in).
 - .3 resist seismic movement where seismic restraint is required in accordance with specification section 20 05 49.
- .5 Adjust motor circuit breakers equipped with adjustable trip settings as required to suit each motor in-rush current requirement.
- .6 Adjust motor overload protection devices equipped with adjustable trip settings to not exceed;
 - .1 125% of motor full load current rating, for motors marked with a 1.15 or higher service factor, and
 - .2 115% of motor full load current rating, for motors marked with a service factor less than 1.15, and for motors that are not marked with a service factor.

3.3 Motor Winding Over-Temperature Protection

- .1 Coordinate with motor suppliers that the motor winding temperature sensors provided by the motor supplier is compatible with the thermal protection control units, as applicable.
- .2 Provide control wiring between PTC sensors in three phase motors and the over-temperature control units located in motor controllers.

3.4 Identification

- .1 Provide identification nameplates for motor controllers and MCC's in accordance with Section 20 05 53.

3.5 Wiring Diagrams

- .1 The included device legend and motor controller wiring diagrams are to be read in conjunction with equipment specifications, control sequences, and motor/starter schedules for implementation of control sequences and identification of components required in each in each motor controller.
- .2 In the following standard details, motor overcurrent protection is shown as a circuit breaker for illustration purposes. Refer to this specification section and other mechanical trades work equipment specification sections for requirements for the use of circuit breakers or fuses.
- .3 The following standard details provide indicative wiring requirements for motor controllers.
 - .1 20 05 14 – 000 Device Legend
 - .2 20 05 14 – 001 Type "A", 3 Phase - Start/Stop
 - .3 20 05 14 – 002 Type "B", 3 Phase - Hand-Off-Auto
 - .4 20 05 14 – 003 Type "BF", 3 Phase - Hand-Off-Auto - Dedicated Smoke Exhaust Fans
 - .5 20 05 14 – 009 Motor Winding Temperature Protection (3 Phase)
 - .6 20 05 14 – 011 Type "K", 1 Phase - On/Off
 - .7 20 05 14 – 012 Type "L", 1 Phase - Hand-Off-Auto
 - .8 20 05 14 – 013 Type "LF", 1 Phase - Hand-Off-Auto - Dedicated Smoke Exhaust Fans

DEVICE SYMBOLS

DISCONNECT	FUSE	MOTOR CIRCUIT PROTECTOR	STARTER	OVERLOADS	MOTOR
DISC 		MCP 	M 	OL 	M
TRANSFORMER	GROUND	CONDUCTORS	TERMINALS	SOLENOID	
H1 X1 		NOT CONNECTED CONNECTED 	1 2 LABELLED TERMINALS ON TERMINAL STRIP 	 (VALVE OR DAMPER)	
RELAY COIL	RELAY CONTACTS	TIME DELAY: ON-DELAY		TIME DELAY: OFF-DELAY	
XX 	CR1 CR1 	TD1-1 NOTC 	TD1-1 NCTO 	TD1-1 NCTC 	TD1-1 NOTO
CONTROL SWITCHES			PILOT LIGHTS		
 MAINTAINED	 MAINTAINED/ SPRING TO OFF	 MOMENTARY			R: RED A: AMBER G: GREEN W: WHITE B: BLUE
PRESS, SWITCH	TEMP. SWITCH	LIMIT SWITCH	FLOW SWITCH	LEVEL SWITCH	METERS
 N.O. N.C.	 N.O. N.C.	 N.O. N.C.	 N.O. N.C.	 N.O. N.C.	 VOLT HOUR AMPS RPM

ABBREVIATIONS

AR	ALARM RELAY	HOA	HAND-OFF-AUTO
CCT	CONTROL CIRCUIT	LS	LIMIT SWITCH
CR	CONTROL RELAY	M	MOTOR
DISC	DISCONNECT SWITCH	MTB	MOMENTARY TEST BUTTON
DPS	DIFFERENTIAL PRESSURE SWITCH	NC	NORMALLY CLOSED
DVR	DOUBLE VOLTAGE RELAY	NO	NORMALLY OPEN
F	FIRESTAT	OL	OVERLOAD
FAS	FIRE ALARM	PB	PUSHBUTTON
FMA	FLOAT MECHANICAL	PE	PRESSURE ELECTRIC SWITCH
FR	FALUT RELAY	PS	PRESSURE SWITCH
FS	FLOW SWITCH	T	THERMOSTAT
FTS	FLOAT SWITCH	TD	TIME DELAY (RELAY)
FZ	FREEZESTAT		

LEGEND

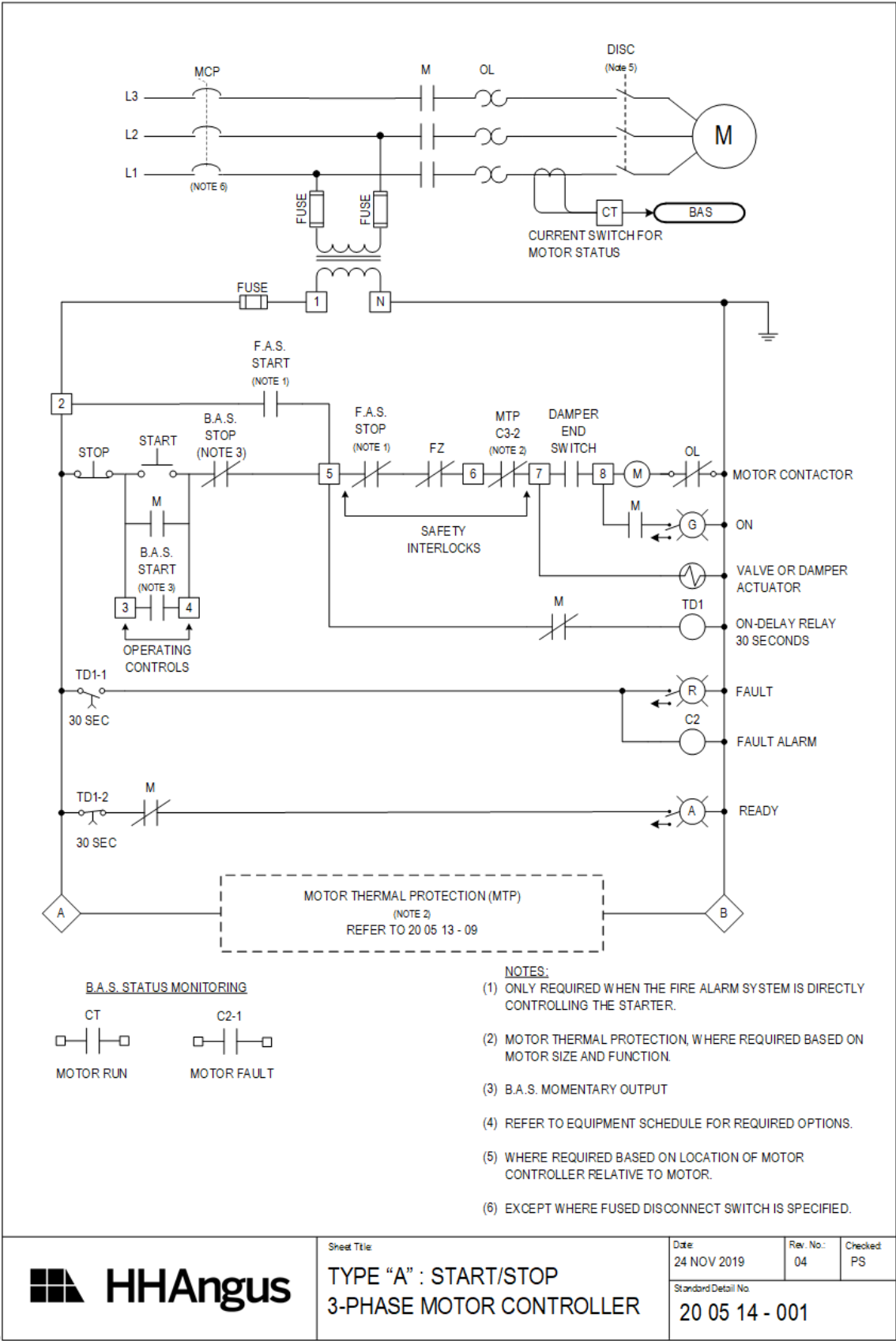
A B	SCOPE OF WORK: DIVISION "A" / DIVISION "B"
	BOUNDARY

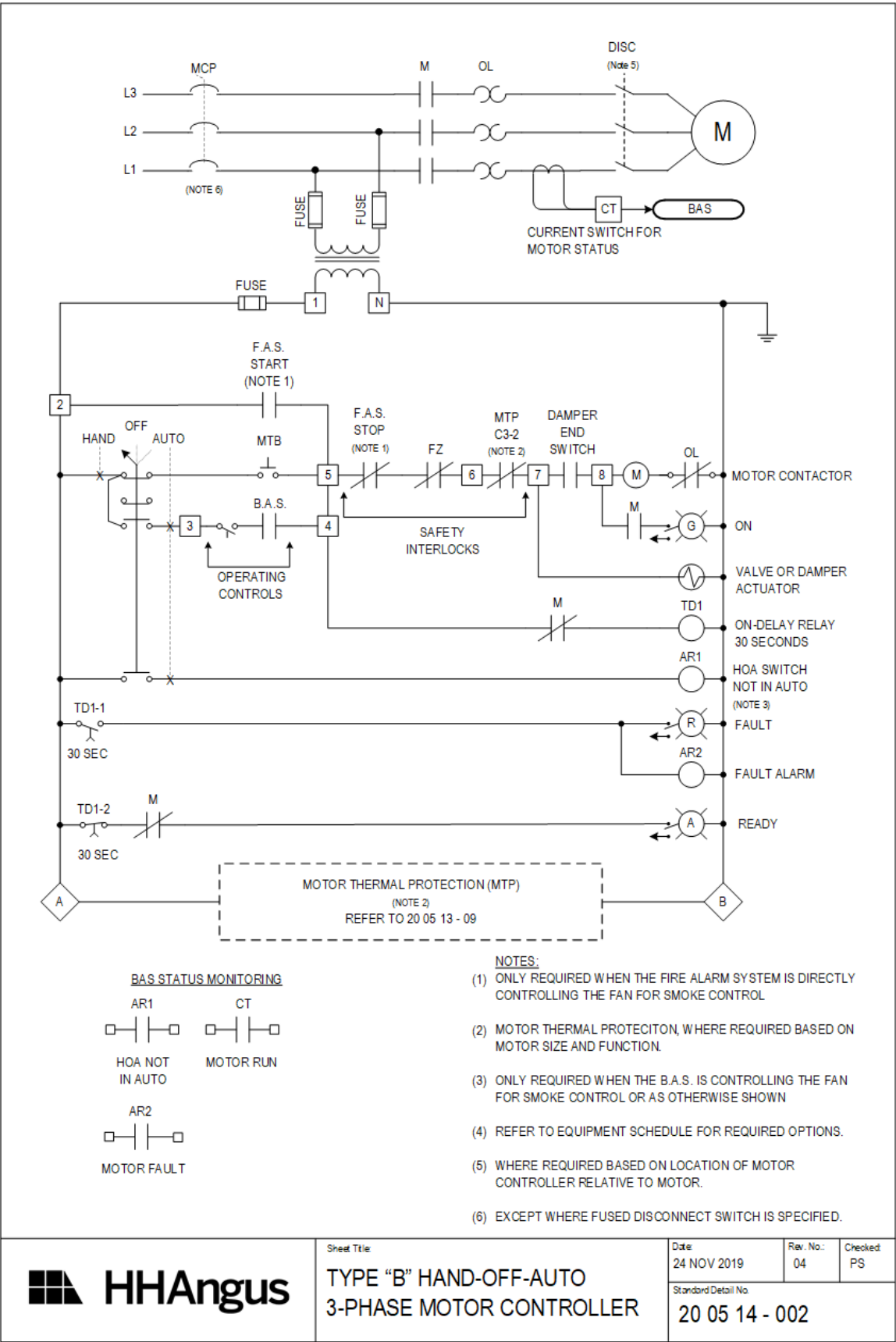
HHA Angus

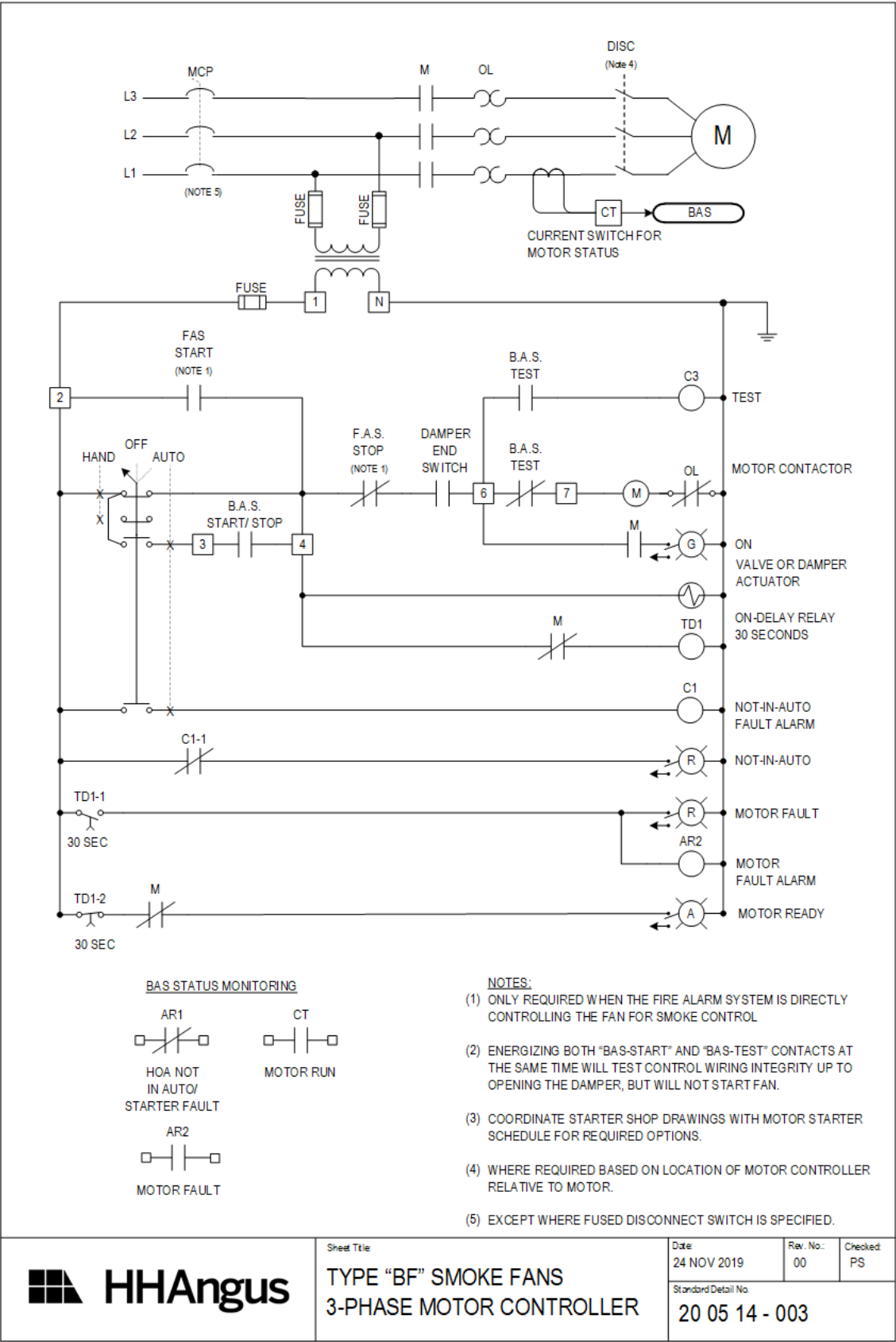
Sheet Title:
**MOTOR CONTROLLERS
DEVICE LEGEND**

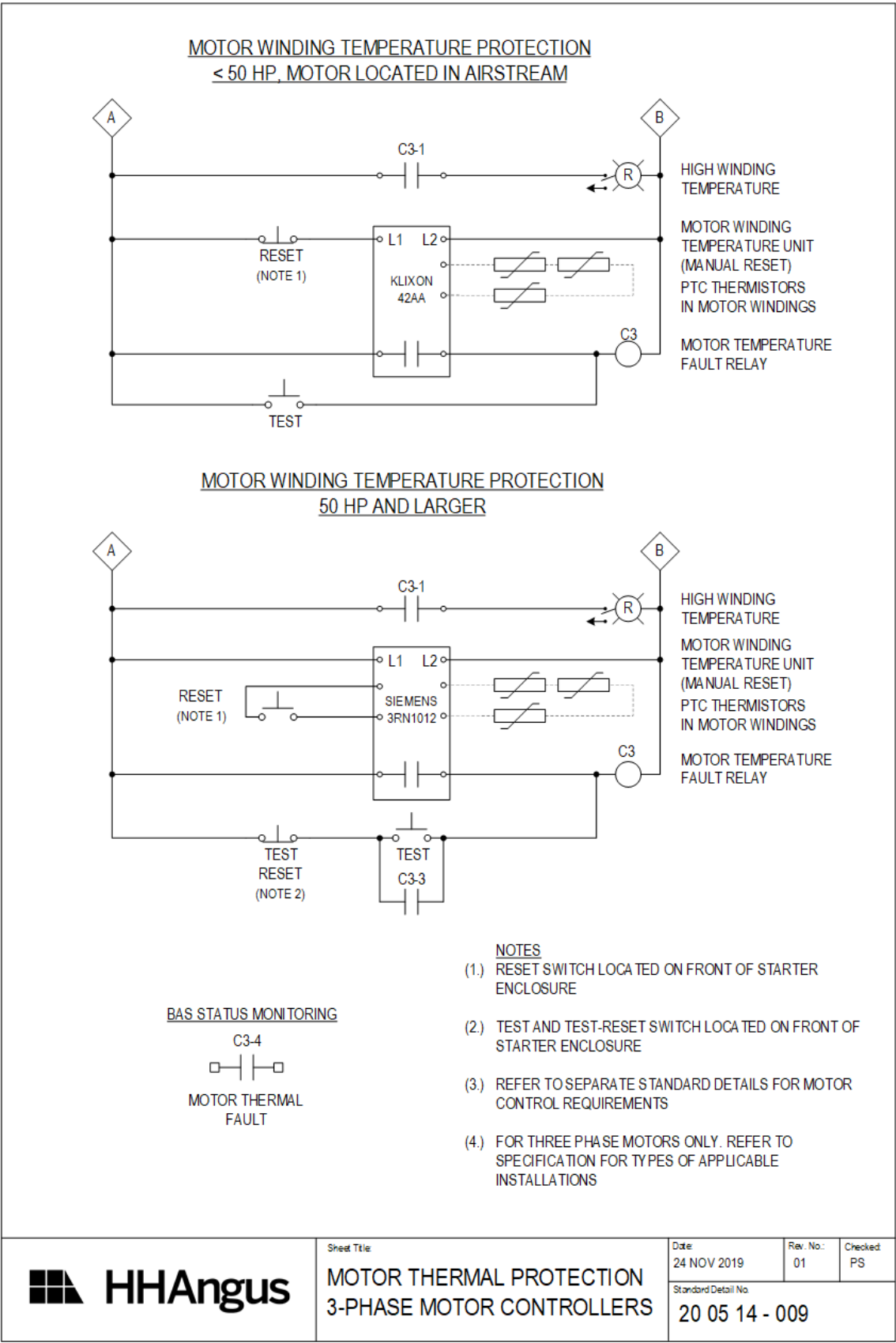
Date 31 MAY 2021	Rev. No.: 02	Checked PS
---------------------	-----------------	---------------

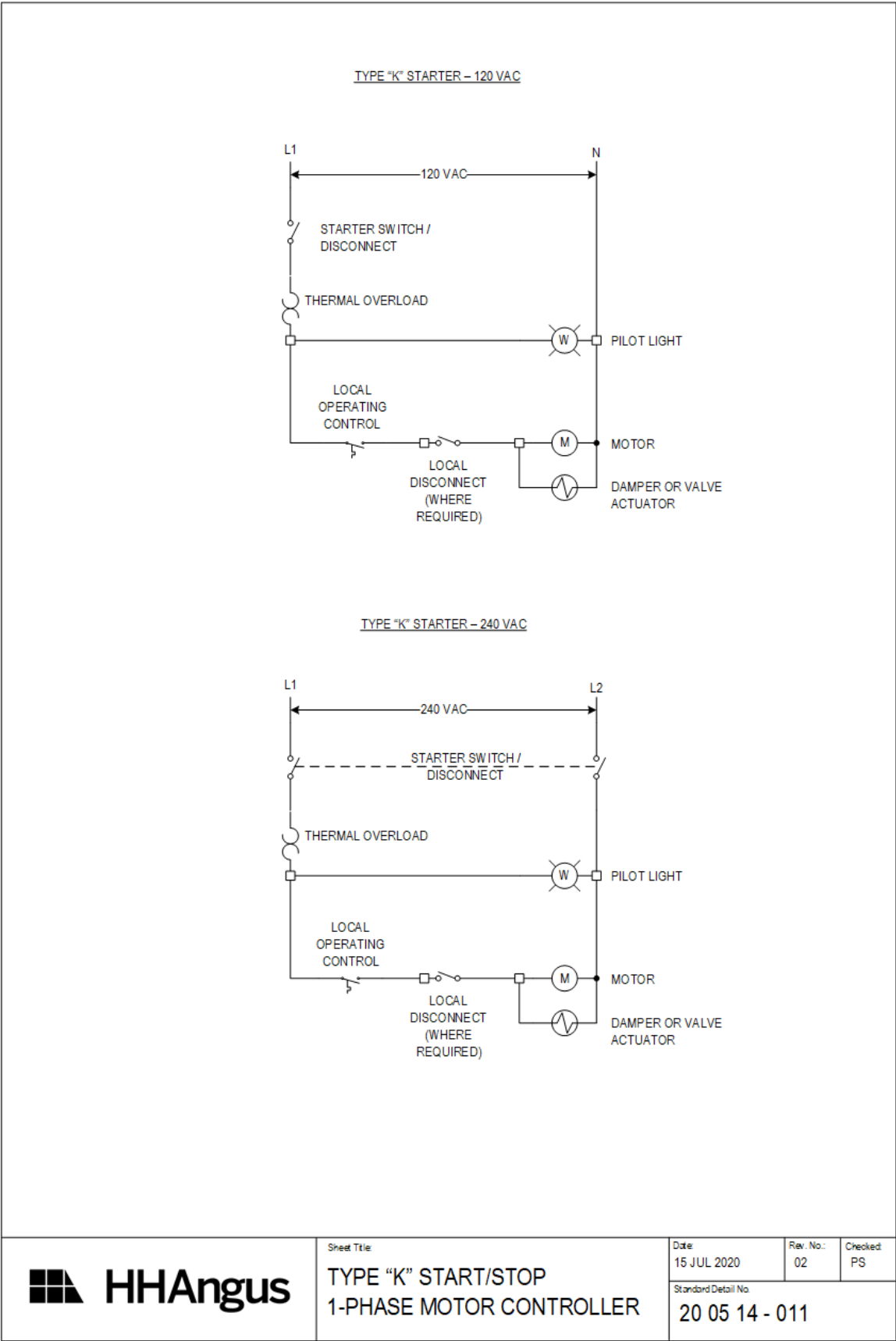
Standard Detail No.
20 05 14 - 000

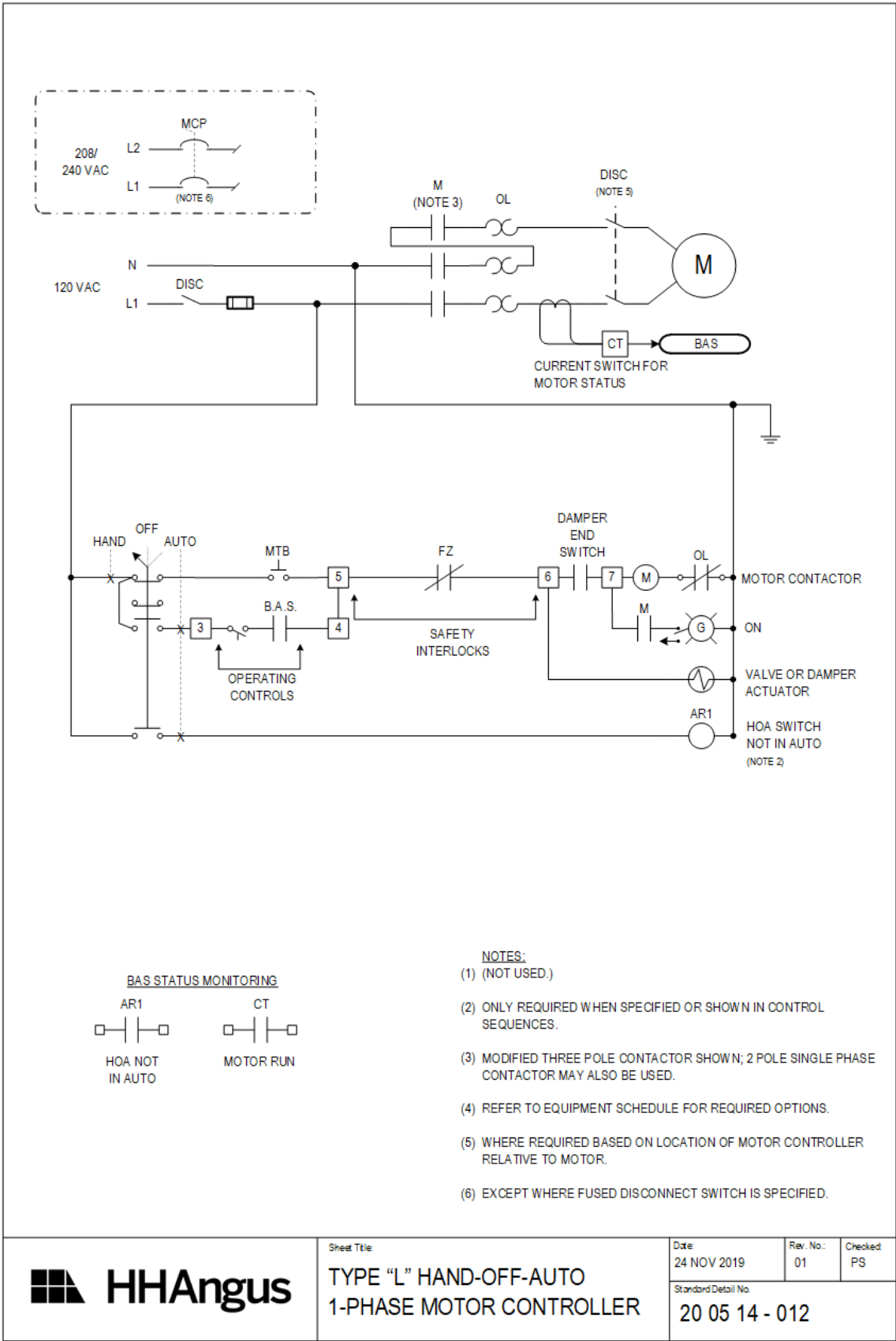


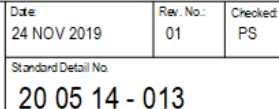












END OF SECTION

Master revised: June 7, 2022

THIS PAGE INTENTIONALLY LEFT BLANK

FLEX CONNECTIONS, EXPANSION JOINTS, ANCHORS & GUIDES

20 05 16

1 GENERAL

1.1 Scope

- .1 Provide flexible connections, expansion joints, pipe anchors, and pipe guides as shown.
- .2 Provide services of expansion joint manufacturer service representative to inspection selected expansion joint installation.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 Refer to each piping specification section for applicable piping installation codes.
 - .2 CAN/CSA-S16.1 Limit States Design of Steel Structures.
 - .3 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .2 Product standards:
 - .1 ASME B1.20.1 Pipe Thread, General Purpose, Inch
 - .2 ASME B16.5 Pipe Flanges and Flange Fittings
 - .3 ASTM A53 Standard Specification for Pipe, Steel, Black and hot dipped, zinc-coated, welded and Seamless
 - .4 ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - .5 ASTM F1120 Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications.
 - .6 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code,
 - .7 CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel.

1.3 Submittals

- .1 Submit manufacturers product data sheets for expansion joint equipment including:
 - .1 Manufacturer name, model number, piping service, pressure and temperature rating.
 - .2 design allowances for axial, lateral and angular movement.
 - .3 nominal size and overall dimensions.
- .2 Submit design drawings sealed by a professional engineer licensed in the province of the Work, for pipe anchors and include;
 - .1 plan drawings showing location of anchors and guides,
 - .2 fabrication details,
 - .3 pipe expansion forces,
 - .4 resulting reaction force and bending moments at building connection,
 - .5 building fastening details.

2 PRODUCTS

2.1 Slip Type Expansion Joints

- .1 Application:
 - .1 for axial pipe movement,
 - .2 travel: 100 mm (4 in) to 300 mm (12 in) single unit, 200 mm (8 in) to 600 mm (24 in) for double units.
 - .3 size: NPS 1-1/2 to NPS 24
- .2 Construction:
 - .1 body and packing housings: Class 150 carbon steel pipe to ASTM A 53, Grade B,
 - .2 wall thickness to match service pipe with flanges or weld ends to match service pipe jointing specification.,
 - .3 adjustable packing gland or fixed packing gland arrangement with a packing injection assembly, arranged for repacking under full line pressure.,
 - .4 slip pipe of carbon steel pipe to ASTM A 53, Grade B, hard chrome plated,
 - .5 anchor base constructed of steel welded to body on double units,
 - .6 internal and external guides in packing housing with concentric alignment of slip pipe,
 - .7 extension limit stop of stainless steel, with accessible and removable pins,
 - .8 not less than six packing rings of teflon or graphite impregnated material,
 - .9 lubricating fittings with grease nipple, pet cocks, and lubricant gun with hose assembly or plunger body of heavy wall carbon steel and plunger of carbon steel with hex head for use with socket wrench.
 - .10 lubricant: to manufacturer's recommendations. .
 - .11 drip connection coupling with drain plug.
 - .12 working pressure: 1030 kPa (150 psig) saturated steam.
 - .13 factory tested to 1½ times maximum working pressure; furnish test certificate.
 - .14 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics – fig. Slip Pak
- Adasco – fig. Ram Pak
- Hyspan - fig. 6500
- Advanced Thermal System – fig. Thermal Pak

2.2 Controlled Ring Expansion Joints

- .1 Application:
 - .1 for axial and lateral movements,
 - .2 travel: up to 190 mm (7.5 in) axial and 38 mm (1.5 in) lateral depending on size.
 - .3 size: NPS 3 to NPS 18
- .2 Construction:

- .1 bellows: hydraulically formed to ASTM F1120, minimum three ply laminated, stainless steel T304 or T321 to ASTM A240,
- .2 stabilizing control rings: two piece nickel iron reinforcing/control rings,
- .3 pipe connections: ASME/ANSI B16.5 flanges, weld ends to ASME/ANSI B16.9, or grooved ends as applicable.
- .4 carbon steel tie rods,
- .5 flow liner: ASTM A240 T304 stainless steel.
- .6 carbon steel painted shroud,
- .7 working pressure: 1030 kPa (150 psig) at up to 425°C (800°F)
- .8 factory tested to 1½ times maximum working pressure; furnish test certificate.
- .9 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics – fig. CSF/CSW
- Adisco - fig. Corrugflex
- Metraflex - fig. MC

2.3 Externally Pressurized Expansion Joints

- .1 Application:
 - .1 for axial movements.
 - .2 travel:
 - (a) single unit: 100 mm (4 in) to 200 mm (8 in)
 - (b) double unit: 200 mm (8 in) to 400 mm (16 in) double unit.
 - .3 size: NPS 2 to NPS 24
- .2 Construction:
 - .1 external pressurized design,
 - .2 bellows: hydraulically formed to ASTM F1120,, minimum three ply laminated, stainless steel T304 or T321 to ASTM A240,
 - .3 housing: ASME A53 Gr B carbon steel,
 - .4 pipe connections: ASME/ANSI B16.5 flanges, weld ends to ASME/ANSI B16.9, or grooved ends as applicable.
 - .5 flow liner: ASTM A240 T304 stainless steel,
 - .6 internal and external guides,
 - .7 working pressure: 1030 kPa (150 psig) and 2070 kPa (300 psig) at up to 260°C (500°F)
 - .8 factory tested to 1½ times maximum working pressure; furnish test certificate.
 - .9 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics – fig. SX, DX
- Adisco - fig. Pressure Master II
- Hyspan - fig. 3500 series
- Metraflex - fig. Metragator

- Flex-Hose Co fig. Flexpress

2.4 Expansion Compensators

- .1 Application:
 - .1 for axial movements,
 - .2 travel:
 - (a) carbone steel: 50 mm (2 in) to 75 mm (3 in)
 - (b) copper tube: 50 mm (2 in)
 - .3 size: NPS ¾ to 3.
- .2 Construction:
 - .1 externally pressurized design,
 - .2 bellows: hydraulically formed to ASTM F1120, minimum three ply laminated, stainless steel T304 or T321 to ASTM A240,
 - .3 pipe ends: schedule 40 ASME A53 Gr B carbon steel,
 - .4 pipe connections:
 - (a) steel pipe: NPT to ASME B1.20.1, or grooved end
 - (b) copper tube: female soldered fitting.
 - .5 flow liner: ASTM A240 T304 stainless steel.
 - .6 NPS ¾ NPT condensate drain connection on outer shell.
 - .7 working pressure: 2070 kPa (300 psig) at up to 400°C (700°F)
 - .8 factory tested to 1½ times maximum working pressure; furnish test certificate,
 - .9 CRN to CSA B51.
 - Senior Flexonics - fig. H2, H3, COPPER
 - Hyspan - fig. 8500
 - Flex-Hose Co fig. FlexComp

2.5 Corrugated-Style Pump and Equipment Connector

- .1 Application:
 - .1 for lateral offset movements and vibration isolation at pumps and other equipment subject to vibration,
 - .2 size: NPS 2 to NPS 10
- .2 Construction:
 - .1 inner tube: T304 stainless steel corrugate tubing,
 - .2 outer braid; Type 304 stainless steel woven mesh braid, to restrain hose from elongation and to limit hose movement,
 - .3 minimum permanent parallel offset:
 - (a) NPS 2-1/2 and smaller: 13 mm (1/2 in.)
 - (b) NPS 3 and larger: 19 mm (3/4 in)
 - .4 pipe connections:

- (a) NPS 2-1/2 and smaller: ASME A53 Schedule 40 pipe with threaded ends to ASME B1.20.1.
- (b) NPS 2-1/2 and larger: ASTM A36 carbon steel flanges to ASME/ANSI B16.5 class 150.
- .5 working pressure: 1100 kPa (160 psig) at up to 121°C (250°F),
- .6 field pressure test: capable of being hydrostatically pressure tested at not less than 120% of unit MAWP, when installed at smallest 90° radii or at maximum parallel offset, at a test temperature of 21°C (70°F),
- .7 factory tested to 1 ½ times maximum working pressure; furnish test certificate,
- .8 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics – fig. BSN/BSFS
- Hyspan - fig. 4500 series
- Metraflex fig. SST/SLP
- Flex-Hose Co - fig. Pumpsaver

2.6 Flexible Rubber Pump and Equipment Connector

- .1 Application:
 - .1 for axial, lateral and angular movements,
 - .2 travel and pipe size:

Parameter	Single Arch	Double Arch
Axial travel	19 mm (3/4 in.)	50 mm (2 in)
Lateral travel	9.5 mm (3/8 in.)	28 mm (1.125 in)
Angular deflection	15°	35°
Pipe size, NPS	1-1/2 to 12	14 to 24

- .2 Construction:
 - .1 Spherical bellows, reinforced EPDM inner liner and outer cover, with wire reinforced flange collars, with floating flanges,
 - .2 tie rod control units with vibration isolation washers,
 - .3 with stabilizing ring for double arch units,
 - .4 working pressure: 1450 kPa (210 psig) at up to 37°C (100°F)
 - .5 factory tested to 1½ times maximum working pressure; furnish test certificate

Standard of Acceptance

- Senior Flexonics – fig. 101/102
- Garlock Canada - fig. 206
- Metraflex - fig. Metrasphere/Doublesphere
- Proco - fig. 231, 232
- Flex-Hose Co fig. FlexZorber series

2.7 Flexible Metal Hose

- .1 Application:
 - .1 for connections to duct mounted reheat coils, and fan coil units.
 - .2 travel limitations;
 - (a) parallel offset equal to the diameter of the hose,
 - (b) single 90 degree bend in one plane.
 - .3 size: NPS 1/2 to NPS 2.
 - .4 hose length:
 - (a) minimum: 300 mm (12 in).
 - (b) maximum for straight or parallel offset: 300 mm (12 in)
 - (c) maximum for one 90 degree bend in one plane: minimum bend radius plus 200 mm (8 in), not including end fittings, or the specified minimum length whichever is greater.
- .2 Construction:
 - .1 inner hose: corrugated T316 or T321 stainless steel,
 - .2 outer jacket: braided T300 series stainless steel wire mesh, to restrain hose from elongation and to limit hose movement,
 - .3 end connections:
 - (a) schedule 40 stainless steel pipe, threaded to ASME B1.20.1,
 - (b) with union at one end connection.
 - .4 working pressure: 2070 kPa (300 psig) at up to 121°C (250°F),
 - .5 field pressure test: capable of being hydrostatically pressure tested at not less than 120% of unit MAWP, when installed at smallest 90° radii or at maximum parallel offset, at a test temperature of 21°C (70°F),
 - .6 factory tested to 1 ½ times maximum working pressure,
 - .7 CRN to CSA B51.

Standard of Acceptance

- Senior Flexonics - fig. 101 series
- Metraflex - fig. SuperFlex
- Flex-Hose - fig. Pumpsaver
- Flexpression - fig. Series I

2.8 Flexible Non-Metallic Hose

- .1 Application:
 - .1 for connections to duct mounted reheat coils, and fan coil units.
 - .2 for connection to duct mounted steam humidifiers at steam pressures not exceeding 100 kPa (15 psig).
 - .3 travel limitations;
 - (a) parallel offset equal to the diameter of the hose,
 - (b) single 90 degree bend in one plane.
 - .4 size: NPS 1/2 to NPS 1-1/4..

- .5 hose length:
 - (a) minimum: 300 mm (12 in).
 - (b) maximum for straight or parallel offset: 300 mm (12 in)
 - (c) maximum for one 90 degree bend in one plane: minimum bend radius plus 200 mm (8 in), not including end fittings, or the specified minimum length whichever is greater.
- .2 Construction
 - .1 inner hose: PTFE inner tube, static dissipating conductive grade,
 - .2 outer jacket: braided T300 series stainless steel wire mesh, to restrain hose from elongation and to limit hose movement,
 - .3 end connections:
 - (a) schedule 40 stainless steel pipe, threaded to ASME B1.20.1,
 - (b) with union at one end connection.
 - .4 working pressure:
 - (a) liquids: 2070 kPa (300 psig) at up to 121°C (250°F),
 - (b) steam: 100 kPa (15 psig) saturated steam
 - .5 CRN to CSA B51.

Standard of Acceptance

- Flexpression - fig. SB, SJ series

2.9 Guides

- .1 Spider guides:
 - .1 pipe size: NPS ¾ to NPS 20
 - .2 axial movement: minimum 200 mm (8 in),
 - .3 carbon steel spider guides, with guide spider clamped to pipe, and guide body with split bolted housing and angle bracket base.

Standard of Acceptance

- Senior Flexonics - fig. PGT
- Hyspan - fig. 9500
- Metraflex - fig. Style IV
- Advanced Thermal System Type GA
- Flex-Hose Co - fig. Guideline

- .2 Horizontal Pipe Support and Slide Guide:
 - .1 Tee or H shaped pipe support for welding to pipe, to allow axial and lateral movements,
 - .2 axial movement: minimum 200 mm (8 in),
 - .3 carbon steel, structural shape or fabricated, to ANSI/MSS SP-58 Type 35,
 - .4 PTFE bonded to underside of slide,
 - .5 matching lower steel plate with bonded PTFE element (for fastening to structural support beam), with lug restraints to limit:

- (a) lateral movement to 1.6 mm (1/6 in) or 25 mm (1 in),
- (b) uplift movement to 1.6 mm (1/6 in),
- .6 operating temperature range: -28 to 200°C (-20 to 400°F),
- .7 nominal pipe size: NPS ½ to NPS 30.

Standard of Acceptance

- Anvil - figs. 257, 436, 439
- Myatt - figs. 705, 706
- Metraflex - fig. PTFE Slide Guide

.3 Vertical Pipe Riser Slide Guide:

- .1 pipe size: NPS 1 to NPS 12,
- .2 axial movement: minimum 200 mm (8 in),
- .3 for welded or clamp attachment to pipe, and bolt attachment to structure floor (top or underside),
- .4 PTFE slide pads,

Standard of Acceptance

- Metraflex - fig. PGQ

.4 Custom guides:

- .1 designed by a professional engineer licensed in the jurisdiction of the Work,
- .2 carbon steel, standard structural shapes conforming to CSA G40.20/G40.21, and hot-dipped galvanized to ASTM A123,
- .3 designed to limit pipe movement to not more than 6 mm (1/4 in) in any lateral direction,
- .4 for insulated piping, provide structural Tee shape with web welded to pipe, and of sufficient height to clear the insulation by not less than 12 mm (1/2 in) at each location.

2.10 Anchors

- .1 Custom designed pipe anchors and combination pipe support anchors.
- .2 Fabrication:
 - .1 designed by a professional engineer licensed in the jurisdiction of the Work,
 - .2 carbon steel, standard structural shapes conforming to CSA G40.20/G40.21, and hot-dipped galvanized to ASTM A123,
 - .3 designed to withstand applied dead loads and live loads including thermal expansion forces and moments including those caused by expansion joint pressure thrust, seismic restraint forces and moments, and wind forces and moments where piping is located outdoors.
 - .4 building structure connection point: specifically designed to suit the structure at the point of attachment, and coordinated with the building structural engineer.
 - .5 for insulated piping, pipe attachments to be of sufficient height to clear the insulation by not less than 12 mm (1/2 in.) at each anchor connection location.

3 EXECUTION

3.1 General

- .1 Provide expansion loops in preference to expansion joints, where space permits.

3.2 Expansion Joints Selection and Installation

- .1 Select expansion joints to compensate for thermal expansion in pipe between anchors with not less than 25% safety margin, calculating expansion based on the following operating temperatures;
- .1 heating systems: from -18°C (0°F) ambient up to maximum possible operating fluid temperature, but not less than 93°C (200°F) for water and design saturation temperature for steam,
 - .2 cooling systems: from 15°C (60°F) ambient down to 5°C (40°F).
- .2 Provide expansion joint types as follows:

Service	Limits	Type
Steam piping Boiler Feedwater piping	Over 1030 kPa (150 psig)	Slip
	501 - 1030 kPa (76 - 150 psig)	Slip, Ring Controlled, or Externally Pressurized
	500 kPa (75 psig) and less	Ring Controlled or Externally Pressurized
Heating water piping Condensate piping Glycol heating piping Chilled water piping Glycol cooling piping Condenser water piping	NPS 20 and larger	Slip
	NPS 3 to NPS 18	Ring Controlled
	NPS 2 to NPS 24	Externally Pressurized
	NPS ¾ to NPS 3	Expansion Compensator
Domestic Hot Water piping Domestic Recirculation Water piping	NPS 2 to NPS 24	Externally Pressurized
	NPS ¾ to NPS 3	Expansion Compensator
Domestic Cold Water piping	NPS 2 to NPS 24	Externally Pressurized

- .3 Provide pressure balanced expansion joints where shown, or they may be provided in lieu of externally pressurized expansion joints, slip joints, or ring controlled ring joints where the design of the anchors would be simplified with their use.
- .4 Support piping immediately adjacent to and on each side of expansion joints and expansion loops. Do not use pipe guides to support the expansion joint or loop.

3.3 Pipe Guides Installation

- .1 Provide pipe guides at each expansion joint and expansion loop:
- .1 provide two guides on each side of and adjacent to the joint or loop;
 - (a) locate the first guide within 4 x pipe diameters from joint or loop,
 - (b) locate the second guide within 10 to 12 x pipe diameter from the first guide, and
 - (c) any additional guides as required to suite anchor design,
 - .2 and otherwise as shown.

.2 Guide installation:

- .1 secure guides to the building structure and arranged to restrict lateral displacement and bowing of pipe adjacent to expansion joint or loop,
- .2 supported from building structure with structural steel angles, channels or plates,
- .3 guides may be omitted between an expansion joint and an adjacent anchor where an anchor is located within minimum distance in accordance with expansion joint manufacturer installation instructions, but not greater than four pipe diameters from the expansion joint.

3.4 Pump Connector Selection and Installation

.1 Provide pump connectors as follows:

Service	Pump Type	Limits	Connector Type
Heating pumps Glycol Heating pumps Condensate pumps	Base Mount	Flange NPS 6 to NPS 14	Bellows
		Flange NPS 4 and smaller	Corrugated
	Vertical In-Line	All	Corrugated
	Circulator	All	None required
Steam Feedwater pumps	Base Mount or Multi-stage	NPS 3 and larger	Bellows
		NPS 2 ½ and smaller	None required
Chilled water pumps Glycol cooling pumps	Base Mount	Flange NPS 10 to NPS 14	Bellows
		Flange NPS 8 and smaller	Corrugated
	Vertical In-Line	All	Corrugated
	Circulator	All	None required
Condenser water pumps	Base Mount	All	Flexible Rubber, Corrugated
	Vertical In-Line	All	Flexible Rubber, Corrugated
Domestic Booster pumps	All	All	Corrugated
Sump pumps (sanitary and storm)	All	All	None required
Fire pumps	All	All	None required

- .2 Provide pump connectors on inlet and discharge side of each pump.
- .3 For vertical-in-line pumps, install connector in vertical portion of piping with pump isolation valves on top of connector; do not install connectors in the horizontal position. Provide pump supports at pipe elbows.
- .4 For base mount pumps, install connectors at pump inlet and outlet flanges.

- .5 Support and guide piping adjacent to pump connector to eliminate lateral misalignment; support piping independently from the connector.
- .6 For bellows type connectors, provide a pipe anchor on the piping as close as practical to the pump connector.

3.5 Equipment Connector Selection and Installation

- .1 Provide pump connectors as follows:

Service	Limits	Connector Type
Refrigeration equipment	Chilled Water Piping	Corrugated
	Condenser Water Piping	Corrugated or Flexible Rubber
	Refrigerant Relief Piping	Corrugated
Cooling Towers	Condenser Water Piping	Flexible Rubber (indoors) Corrugated (outdoors)
	Domestic Water Piping	Corrugated
Air compressors (except medical air compressors)	Inlet piping	None required
	Outlet piping	Corrugated
Medical Air Compressor Medical Vacuum Pumps	All	None required
Domestic Hot Water Tanks	Inlet and Discharge piping NPS 3 and larger	Corrugated
	Inlet and Discharge piping NPS 2 ½ and smaller	None required
Steam, heating and cooling coils, and humidifiers	Air handling units supported on spring vibration isolators	Flexible Metal Hose
	Other air handling units	None required
Hot water reheat coils, Fan Coil units	Optional : All sizes	Flexible Metal Hose, Flexible Non-Metallic Hose
Duct mounted humidifiers	Optional: All sizes	Flexible Non-Metallic Hose

- .2 Connector and hose sizing:
 - .1 nominal diameter: same size as piping serving the equipment, not the equipment fitting size.
- .3 Support or guide piping firmly adjacent to equipment connectors and prevent pipes from swaying.
- .4 Where equipment connectors are to be installed at steam coils, locate connectors;
 - .1 between control valve and coil on steam supply side, and
 - .2 after steam trap on condensate line.
- .5 Where equipment connectors are to be installed at chilled and/or hot water coils, locate connectors;
 - .1 between strainer and coil on the supply side, and
 - .2 between coil and control valve on return side
- .6 At reheat coils installed in terminal boxes or in ductwork, arrange equipment connectors so there are no bends, and no axial offsets greater than the OD of the connector measured from the centerline of the connector.

3.6 Multi-axis Flexible Pipe Loops Installation

- .1 Install flexible pipe loops in accordance with manufacturer installation instructions, but not less than the following:
 - .1 provide a pipe anchor within four (4) pipe diameters on each end of the pipe loop, or
 - .2 provide a pipe guide within four (4) pipe diameters, and a pipe anchor within 10 to 14 pipe diameters, on each end of the pipe loop, or
 - .3 a combination of the above.
- .2 Unless otherwise shown for the loop to be hung in the vertical plane, install the loops so they are in the horizontal plane to conserve headroom.
- .3 Where the loop is orientated horizontally, provide a pipe hanger with variable spring support at each cantilevered elbow to allow movement of the elbow in all required directions. Size the spring support to allow full design movement in all axis.
 - .1 where movement in the vertical (Z) axis is zero, a sliding base support may be used provided it fully supports the elbow in the X and Y axis under all displacement. Provide a 3 mm (1/8" thick) Teflon pad on the pipe support surface, and a similar pad secured to the pipe (for uninsulated pipes) or to the insulation shield or saddle (for insulated pipe).
- .4 Where multiple adjacent runs of piping occur, nest the loops to minimize space requirements. Size each nested loop so that the smallest loop meets the required movement dimensions.

3.7 Piping Anchor Installation

- .1 Design anchors suitable for locations shown;
 - .1 submit shop drawings sealed by a professional engineer licensed in the jurisdiction of the project,
 - .2 include connection loads to the building structure to be reviewed by the Structural Engineering Consultant
- .2 Fabricate piping anchors from structural steel angles, channels, or plates secured directly to piping and the building structure unless otherwise shown:
 - .1 single leg design, for piping NPS 4 and smaller and where distance between side of pipe and building attachment point is 600 mm (24 in) and less,
 - .2 minimum four-contact point design for all other distances.

3.8 Manufacturer's Inspection of Anchor and Guide Installation

- .1 Make arrangements and pay for expansion joint manufacturer's field representative to review anchors and guides around expansion joints on;
 - .1 steam piping
 - .2 domestic hot water and recirculating water piping NPS 6 size and larger
 - .3 heating system and chilled water piping NPS 8 size and larger
- .2 Submit written report, prepared by field representative, confirming that expansion joints, anchors, and guides are installed in accordance with joint manufacturer's recommendations.

3.9 Start-Up and Testing

- .1 Prior to placing expansion joint in service, apply match-marks to joint flanges/connectors to record axial, lateral, rotation and angular movement of joint connections. After system is at operating temperature, inspect match-marks and record displacement of joint connections compared to pre-start conditions. Submit report including photos of displaced match-marks.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

INDICATING GAUGES

20 05 19

1 GENERAL

1.1 Scope

- .1 Provide temperature and pressure measuring devices and flow indicators as shown.

1.2 Submittals

- .1 Submit manufacturer's catalogue literature for;
 - .1 flow indicators,
 - .2 thermometers,
 - .3 pressure gauges.
- .2 Product data sheets to include:
 - .1 measurement range,
 - .2 maximum operating pressure,
 - .3 installation accessories
- .3 Where there are multiple piping system design pressures based on building elevation, submit separate shop drawings for measuring and indication devices based on applicable piping system design pressure.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boiler and Pressure Vessel Code
- .2 Product standards:
 - .1 ASME B40.100 Pressure Gauges and Gauge Attachments
 - .2 ASME B40.200 Thermometers, Direct Reading and Remote Reading
 - .3 ASME PTC 19.3 TW Thermowells

1.4 Quality Control

- .1 All products that are connected to or installed in a piping system are to have Canadian Registration Numbers in accordance with CSA B51.

2 PRODUCTS

2.1 Thermometers and Pressure Gauges - Selection Criteria

- .1 General:
 - .1 normal operating reading to be between one-half and two-thirds of full scale range,
 - .2 expected maximum and minimum readings to be within scale range.
 - .3 thermometers to have both Celsius and Fahrenheit scales,
 - .4 pressure gauges to have both kPa and psi scales.
 - .5 select pressure gauges and thermometers from manufacturer's standard product line.

Standard of Acceptance

- Terice
- Ashcroft
- Dwyer
- Weksler
- Winter
- Weiss
- WIKA

2.2 Direct Reading Thermometers – Liquid and Gases

- .1 For liquid and compressed gas service only.
- .2 Industrial, adjustable angle type;
 - .1 indicator: 225 mm (9 in.) long, coloured organic spirit fill, magnifying lens type,
 - .2 measurement units: dual scale °C/ °F,
 - .3 case: cast aluminum with epoxy finish,
 - .4 window: UV stabilized acrylic for temperature range up to 150°C (300°F), and glass for higher temperatures,
 - .5 process connection: NPT threaded mount, and constructed of:
 - (a) for carbon steel pipe: brass,
 - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
 - (c) for copper tube: brass
 - .6 accuracy: ± 1 unit minor scale division,
 - .7 conforms to ASME B40.200,
 - .8 with matching thermowell.

Standard of Acceptance

- Terice – fig. BX9

2.3 Remote Reading Thermometers

- .1 Surface-mounted remote reading thermometer:
 - .1 115 mm (4½ in) liquid filled or gas activated type,
 - .2 capillary sensing tube: armoured stainless steel capillary tube with union fitting connection, of length required to suit installation requirements,
 - .3 measurement units: dual scale °C/ °F,
 - .4 case: cast aluminum with epoxy finish, with mounting ring,
 - .5 window: clear glass with retaining ring or hinged bezel,
 - .6 process connection: NPT threaded mount, and constructed of:
 - (a) for carbon steel pipe: brass,
 - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
 - (c) for copper tube: brass
 - .7 accuracy: ± 1 unit minor scale division,

- .8 conforms to ASME B40.200,
- .9 with matching thermowell.

Standard of Acceptance

- Trerice - fig. V/L80341 (gas/liquid activated)
- Weksler - fig. 413B (gas activated)
- Ashcroft - fig. 600A Series (gas activated)

2.4 Thermometer Wells (Thermowells)

- .1 Manufactured from bar stock or forged brass,
 - .1 compatible with temperature sensors used,
 - .2 external NPT mounting threads,
 - .3 pressure rating: 2000 kPa (300 psig) at 121°C (250°F)
 - .4 C.R.N. registered.
- .2 Body material:
 - .1 for carbon steel piping: brass,
 - .2 for copper and brass tubing: brass.
 - .3 for stainless steel piping: 304 stainless steel.
- .3 C.R.N. to CSA B51.

Standard of Acceptance

- Trerice - fig. 4350

2.5 Temperature Well Conversion Kits

- .1 Retrofit kit to convert straight liquid filled thermometer wells to accept bi-metal dial thermometers.

2.6 Pressure Gauges – Liquid and Steam Process

- .1 For measurement of pressure piping for liquid and steam systems.
- .2 Direct pressure measurement:
 - .1 display: Ø115 mm (4½ in. dia.) dial type, dry type, adjustable stainless steel pointer movement
 - .2 measurement units: dual scale kPa/ psi,
 - .3 case: fiberglass reinforced polypropylene, solid-front and blow-out back,
 - .4 window: acrylic,
 - .5 wetted parts:
 - (a) for carbon steel pipe: brass,
 - (b) for stainless steel pipe or tube: 316L stainless steel tube and socket,
 - (c) for copper tube: brass
 - .6 accuracy: 0.5% full scale reading,
 - .7 maximum service temperature: 121°C (250°F)
 - .8 conforms to ASME B40.100 Grade 2A.
 - .9 C.R.N. to CSA B51.

Standard of Acceptance

- ° Terice – 450B, 450SS

2.7 Pressure Gauges – Ventilation

- .1 For measurement in HVAC ventilation systems.
- .2 Direct or differential pressure measurement:
 - .1 process service: ventilation air,
 - .2 display: Ø115 mm (4½ in. dia.) dial type, adjustable stainless steel pointer movement, pressure relief plug, and NPT 1/8 low- and high-pressure inlet ports, and tubing adaptors,
 - .3 measurement units: dual scale Pa / in. w.c.
 - .4 case: cast aluminium with bezel with epoxy finish coat,
 - .5 window: acrylic,
 - .6 accuracy: ±2% full scale reading,
 - .7 service pressure range: -500 mm Hg to 103 kPa (- 20 in.Hg. to 15 psig)
 - .8 maximum service temperature: -6.5°C to 60°C (20 to 140°F),
 - .9 accessories:
 - (a) attached surface mounting plate,
 - (b) adjustable signal flag for measurement across air filter banks.

Standard of Acceptance

- ° Dwyer - fig. 2000, 2000-ASF series

2.8 Pressure Gauge Accessories

- .1 Pressure snubbers:
 - .1 brass or T303 stainless steel construction,
 - .2 C.R.N. to CSA B51.

Standard of Acceptance

- ° Terice - 872

- .2 Gauge isolation ball valves:
 - .1 for water, compressed gases, and fuel oil services,
 - .2 NPS 1/4, brass body, quarter-turn ball valves with Teflon seats,
 - .3 minimum pressure rating: 2000 kPa (300 psig) at 121°C (250°F),
 - .4 C.R.N. to CSA B51.

Standard of Acceptance

- ° Terice - fig. 866

- .5 alternate product: NPS 1/4 or 1/2 size as specified for associated liquid or gas piping system.
- .3 Gauge isolation valves for steam service:

- .1 isolation valves as specified for associated steam piping system.
- .4 Coil syphons:
 - .1 1/4" NPT x 180° coil, seamless 304SS, schedule 40 body,
 - .2 minimum pressure rating: 3500 kPa (500 psig) at 343°C (650°F),
 - .3 C.R.N. to CSA B51.

Standard of Acceptance

- ° Tereice – 885-4

2.9 Test Port Plugs

- .1 Piping test port plugs with gauge adaptors for pressure tests or insertion of pocket thermometer probes.
 - .1 Wetted parts: lead-free brass, with BUNA-diaphragm core,
 - .2 size: 1/2" NPT with MNPT threaded connection, with probe guard
 - .3 pressure rating: 7000 kPa (1000 psi) from -40 to 150°C (-40 to 300°F)

Standard of Acceptance

- ° Winters – fig. STP-LF

3 EXECUTION

3.1 Installation - General

- .1 Install thermometers and gauges not more than 3 m (10 ft) from floor or platform, or install remote reading thermometers and gauges, with dial mounted at eye level, mounted on backplate and fastened to building structure.
- .2 Provide nameplates for each gauge and thermometer as specified in Section 20 19 00 Identification.

3.2 Thermometer Installation

- .1 Install thermometers on inlet and outlet of;
 - .1 heat exchangers,
 - .2 water heating and cooling coils,
 - .3 water boilers,
 - .4 chillers,
 - .5 open-circuit cooling towers and closed-circuit water coolers,
 - .6 domestic hot water tanks, and
 - .7 as shown.
- .2 Install thermometers in thermowells.
- .3 Install thermowells with extension necks where piping and equipment is to be insulated.

3.3 Pressure Gauge Installation

- .1 Install pressure gauges on inlet and outlet of;
 - .1 heat exchangers,
 - .2 water heating and cooling coils,

- .3 steam piping to heating coils (inlet only),
 - .4 water boilers,
 - .5 chillers,
 - .6 closed-circuit water coolers,
 - .7 domestic hot water tanks,
 - .8 steam boilers,
 - .9 condensate receivers,
 - .10 deaerators,
 - .11 air-compressors (discharge only),
 - .12 compress-air dryers,
 - .13 compressed-air receivers, and
 - .14 as shown.
- .2 Provide an isolation valve for each pressure gauge. For differential pressure gauges, provide an isolation valve on each high and low pressure sensing lines.
- .3 Provide pressure snubbers on pressure gauges at the following locations:
- .1 suction and discharge sides of positive-displacement pumps including oil pumps,
 - .2 air-compressor discharge, and inlet and discharge of compressed-air dryers, and at outlet of compressed-air receivers,
- .4 Install coil syphons on steam and condensate pressure gauges.

3.4 Test Port Plugs

- .1 Install test port plugs in locations as shown. Test port plugs shall not be used in lieu of temperature or pressure gauges specifically shown.

END OF SECTION

GENERAL REQUIREMENTS FOR VALVES

20 05 23

1 GENERAL

1.1 Scope

- .1 Provide valves in piping systems for shut-off service, manual flow balancing, check-stops and valve bodies for automatic flow control.
- .2 This specification section provides general requirements for valves.

1.2 Related Sections

- .1 Refer to the following valve specification sections for requirements for general-duty valves in addition to the general requirements specified herein.
 - 21 05 23 General-Duty Valves for Water-Based Fire-Suppression Piping
 - 22 05 23.13 General-Duty Valves for Plumbing Piping
 - 22 05 23.19 General-Duty Valves for Sewage Piping
 - 22 15 16 General Service Compressed-Air Valves
 - 23 05 23.13 General-Duty Valves for HVAC Water Piping
- .2 Refer to the following specifications sections for requirements for specific-duty valves in addition to the general requirements specified herein.
 - 25 35 01 B.A.S – Instrumentation and Actuators

1.3 Submittals

- .1 Submit manufacturer product data-sheets for valves, including pressure-temperature ratings with confirmation that the valve meets the required MCPR rating specified for each valve.
- .2 Where valves are specified to be listed (certified) to a standard, include the following information for each affected product:
 - .1 applicable standard by name and reference number,
 - .2 name of accredited testing organization or their mark who certified the product, and
 - .3 the testing organization file reference number.
- .3 Where valves are required to have a CRN, include the CRN and its expiry date on each valve submittal.
- .4 Where manufacturer pre-printed data-sheets do not include this information, a schedule may be submitted which includes the manufacturers name, model number and the required listing and/or CRN information described above. Where the product is name-branded for a manufacturer, include the name of the source manufacturer.

1.4 Applicable codes and standards

- .1 Legislation:
 - .1 Valves installed in piping systems which are subject to provincial or federal pressure piping legislation shall have current Canadian Registration Numbers ("CRN") in accordance with CSA B51.
- .2 Installation standards, codes and guidelines:
 - .1 CSA B51 Boiler and Pressure Vessel Code.

.2 Refer to applicable piping specification sections for any other specific requirements.

.3 Product standards:

- | | | |
|-----|-------------------|--|
| .1 | ANSI/ASME B1.20.1 | Pipe Threads, General Purpose, Inch |
| .2 | ASME B16.1 | Cast Iron Pipe Flanges and Flanged Fittings |
| .3 | ASME B16.5 | Pipe Flanges and Flanged Fittings |
| .4 | ASME B16.10 | Face-to-Face and End-to-End Dimensions of Valves |
| .5 | ASME B156.24 | Cast Copper Alloy Pipe Flanges and Flanged Fittings |
| .6 | ASME B16.34 | Valves Flanged, Threaded and Welding Ends |
| .7 | ASME B16.47 | Large Diameter Steel Flanges: NPS 26 Through NPS 60 |
| .8 | ISO 5211 | Industrial Valves – Part-turn Actuator Attachments |
| .9 | MSS SP-25 | Standard Marking System for Valves, Fittings, Flanges, and Unions |
| .10 | MSS SP-42 | Corrosion-Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt Weld Ends (Classes 150, 300, & 600) |
| .11 | MSS SP-67 | Butterfly Valves |
| .12 | MSS SP-68 | High Pressure Butterfly Valves with Offset Design |
| .13 | MSS SP-70 | Cast Iron Gate Valves, Flanged and Threaded Ends |
| .14 | MSS SP-71 | Cast Iron Swing Check Valves, Flanged and Threaded Ends |
| .15 | MSS SP-72 | Ball valves with Flanged or Butt-Welding ends for General Service |
| .16 | MSS SP-78 | Cast Iron Plug Valves |
| .17 | MSS SP-80 | Bronze Gate, Globe Angle and Check Valves |
| .18 | MSS SP-85 | Cast Iron Globe and Angle Valves, Flanged and Threaded Ends |
| .19 | MSS SP-110 | Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |
| .20 | MSS SP-125 | Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves |
| .21 | MSS SP-126 | In-Line, Spring-Assisted, Center-Guided Check Valves (Carbon, Alloy Steel, Stainless Steel, & Nickel Alloys) |
| .22 | MSS SP-136 | Ductile Iron Swing Check Valves |
| .23 | MSS SP-139 | Copper Alloy Gate, Globe, Angle, and Check Valves for Low Pressure/Low Temperature Plumbing Applications |
| .24 | NSF/ANSI 61 | Drinking Water System Components – Health Effects |
| .25 | NSF/ANSI 372 | Drinking Water System Components – Lead Content (formerly NSF/ANSI 61- Annex G). |

1.5 Quality and Equivalence

- .1 Valve selections are in general identified by model designations taken from manufacturers catalogues to indicate physical properties and quality requirements not otherwise described.

2 PRODUCTS

2.1 General

- .1 Refer to related specification sections.
- .2 Manufactures and/or trade names listed in Table 1 are acceptable for various indicated valve types, where products offered are essentially similar to those identified by manufacturer or model number under "Standard of Acceptance" designation in the related specification sections.
 - .1 Refer to the General-duty valve specification sections and specific-duty valve requirements contained in the related piping system specification sections.
 - .2 Additional specification requirements and/or certification requirements may be required by those sections.

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
A-Chem Valves & Controls	•			•		•
American Valve						•
APCO		•				
Apollo				•		•
Bonney Forge	•					
Beric	•					
Bray				•		•
Canadian Worchester Controls						•
Challenger				•		
Couplox				•		
Crane	•			•		•
Crane Centreline				•		
Crane Flowseal				•		
Dahl Bros	•					•
Demco				•		
DeZurik				!		
Durabla		•				
Grinnell				•		
Gruvlok				•		•
Hattersley Milliken (Crane)					•	
Jenkins	•			•		•
Keystone				•		
Kitz	•			•		•
MA Stewart (MAS)	•					•
Milwaukee Valve				•		•
Mueller		•		•	•	

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
Neo Valves	•					•
Nibco	•	•		•		•
Nordstrom					•	
Powell	•					
Preso			•			
S.A. Armstrong	•		•			
Shurjoint				•		•
Sure Seal				•		
Tour & Anderson			•			
Toyo Valve (Red & White)	•					•
Triad				•		
Trueline	•					•
Valmatic		•				
Velan	•			•		•
Victaulic				•		•
Watts	•			•		•
WKM				•		

3 EXECUTION

3.1 Valve Selection Criteria

- .1 Select valves in accordance with function criteria as shown in Table 2.

Table 2: Valve Function Selection						
Function	Gate	Butterfly	Ball	Globe	Plug	DRV
Shut-Off	•	•	•		•	
Flow balancing and shut-off					• [1] [2]	•
Flow Balancing only (excluding pumps)				•		•
Pump Balancing		• [1] [3]		•		•

Notes:

[1] Gear operator with position limit memory stops.

[2] Non-lubricated plug valve designed for flow balancing.

[3] Sized one (1) NPS line size smaller than pipe line size (not pump discharge size).

3.2 Piping System Drain Valves

- .1 Provide drain valves on piping and at equipment as follows unless otherwise shown on drawings:
 - .1 On pipe mains and branches NPS 3 and under, and for equipment with pipe connections NPS 4 and smaller:
 - (a) NPS $\frac{3}{4}$ ball valve in accordance with pipe system specification with integral NPSH $\frac{3}{4}$ hose end with cap and chain.
 - .2 On pipe mains NPS 4 to NPS 6, and for equipment with pipe connections NPS 6 and larger:
 - (a) NPS 1 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug
 - .3 On pipe mains NPS 8 and larger:
 - (a) NPS 2 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug.

3.3 Valve Installation - General

- .1 Install shut off valves at:
 - .1 branch take-offs,
 - .2 to isolate piping to each piece of equipment, and
 - .3 in locations shown.
- .2 Remove internal parts of valves before soldering, welding or brazing pipe to valve body.
 - .1 Exception: where valve is provided with tube end extensions to allow soldering or brazing without removal of internal parts.
 - .2 For valves which do not permit disassembly including ball valves and inline check valves, comply with valve manufacturer instructions to protect valve internal components during soldering, brazing or welding.
- .3 Install triple duty or throttling valves where shown in pump discharge piping with ten pipe diameters of straight pipe on the inlet side and two pipe diameters on outlet side.
- .4 Install butterfly valves between weldneck or slip-on flanges.

3.4 Valve Orientation and Accessibility

- .1 Arrange valve hand-wheels and operating levers to be accessible.
- .2 In equipment rooms and service spaces provide chain operators for valves mounted more than 2m (6 ft) above floor or access platform. Provide sufficient chain length to extend to 1.5m (4 ft-6 in) above floor or platform and to be hooked on clips secured to building structure, clear of walking aisles.
- .3 In horizontal piping (see figure 1);
 - .1 For OS&R valves, install the valve with stem vertical where the valve centerline is not more than 1200 mm above the adjacent floor or access platform. For greater heights, install the valve with stem horizontal. Where space is restricted, the valve may be installed with the valve spindle at a 45° angle from the vertical where the valve centerline is not more than 1500 mm above the floor or access platform.
 - .2 For gear operated valves, install with gear-box on top of the valve and hand-wheel shaft in the horizontal position.
 - .3 For lever operated valves, install with handle on top of valves where the valve centerline is not more than 1500 mm above the floor or access platform. Where spaces is restricted, the valve may

be positioned with the lever handle shaft in the horizontal position. For greater heights, install valves with handle shaft in the horizontal position.

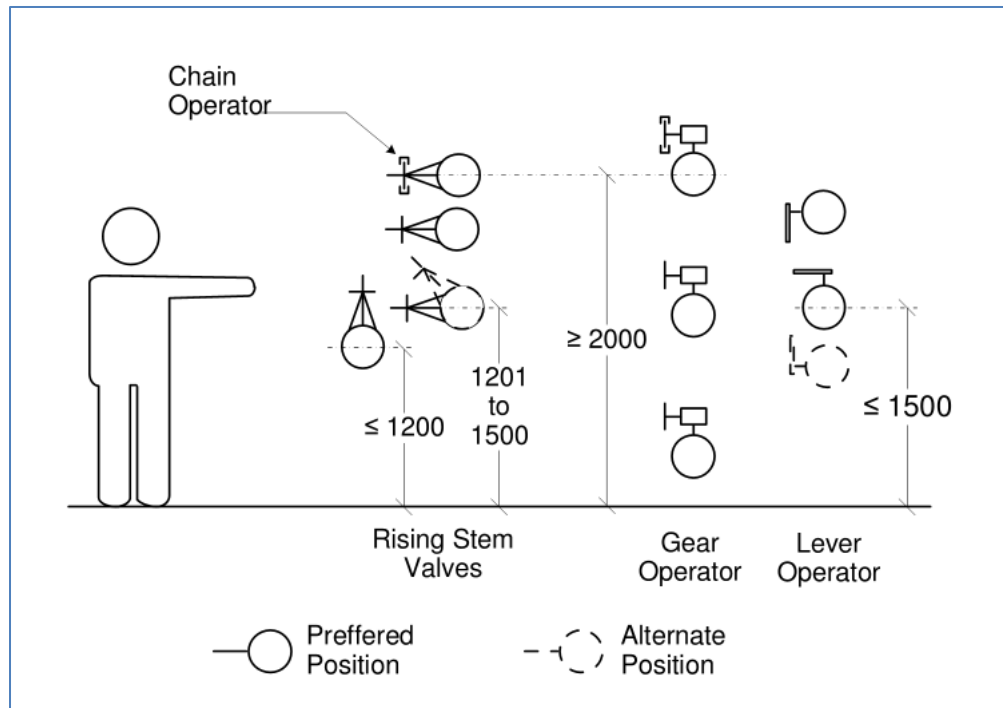


Figure 1: Valve Spindle Arrangement

- .4 In vertical piping, install with valve stem facing directly towards the means of access. Where access space in front of the valve is less than 900 mm (36 in), rotate the valve 45° from the straight forward position.

3.5 Double Regulating Valves Installation

- .1 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow
- .2 Size and select valves for flows as shown, based on at 6 kPa (2 ft) pressure drop across the valve in the fully open position, and in accordance with manufactures recommendation. Table 3 identifies the nominal valve size selection:

Table 3: Double Regulating Valve Nominal Sizing				
Valve Size (in)	Nominal Flow			
	Min. (l/s)	Max. (l/s)	Min. (gpm)	Max. (gpm)
½	0.038	0.177	0.6	2.8
¾	0.126	0.379	2.0	6.0
1	0.246	0.631	3.9	10.0
1-¼	0.316	0.947	5.0	15.0
1-½	0.416	1.262	6.6	20.0
2	0.795	2.272	12.6	36.0
2-½	2.398	6.310	38.0	100.0
3	1.956	8.203	31.0	130.0

Table 3: Double Regulating Valve Nominal Sizing				
Valve Size (in)	Nominal Flow			
	Min. (l/s)	Max. (l/s)	Min. (gpm)	Max. (gpm)
4	4.291	12.620	68.0	200.0
5	5.679	20.192	90.0	320.0
6	11.48	28.395	182.0	450.0
8	23.16	51.742	367.0	820.0
10	34.07	82.030	540.0	1300.0
12	60.58	94.650	960.0	1500.0

- .3 Install double regulating valves with five pipe diameters of straight pipe on inlet side, two pipe diameters on outlet side and 10 pipe diameters from any pump.
- .4 Install double regulating valves with ports facing horizontal or facing up. Do not install with ports facing down to prevent debris from falling and accumulating inside the ports.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

WELDING AND BRAZING

20 05 24

1 GENERAL

1.1 Scope

- .1 Weld or braze pipe and fittings for work of Division 20.

1.2 Definitions

- .1 The following definitions apply to this specification section:

AHJ (BPV): *the authority having jurisdiction which is responsible for boiler, pressure vessel and pressure piping safety in the province of the project.*

- .2 In this specification,
 - .1 the word “piping” also includes tubing as the case applies.
 - .2 the words “welding” or “welder” shall be read as to also refer to “brazing” or “brazer” unless the context otherwise dictates one or the other.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ASME B31.1 Pressure Piping
 - .2 ASME B31.3 Process Piping
 - .3 ASME B31.9 Building Services Piping
 - .4 ASME BPVC Section V Nondestructive Examination
 - .5 ASME BPVC Section IX Welding and Brazing Qualifications
 - .6 CSA B51. Boiler, Pressure Vessel, and Pressure Piping Code

1.4 Quality Control

- .1 Welding of piping systems which have specified design pressures greater than 100 kPa (15 psi) to be carried out using approved welding procedures by welders certified for pressure piping by the AHJ (BPV), whether or not the piping system is subject to registration as pressure piping.
- .2 Welding procedures shall be registered with the AHJ (BPV), in accordance with CSA B51 and as qualified in accordance with ASME BPVC Section IX.
- .3 Welders shall be certified for welding of pressure piping in accordance with the requirements of the AHJ (BPV). Welders shall be qualified by their employer on the employers welding procedures.
- .4 For piping systems which have specified design pressure of 100 kPa (15 psi) or less, welding procedures and welders shall be qualified by the Contractor in accordance with the requirements of ASME B31.9.

2 PRODUCTS

2.1 Not used

3 EXECUTION

3.1 Welding Method and Quality

- .1 Welding, both shop and field, to be electric arc in accordance with recommendations of Canadian Welding Bureau unless other welding methods are specified in the piping specification sections.
- .2 Welds to be solid homogeneous part of metals joined and free from pits, slag-inclusions, and scale.
- .3 Weld surfaces to be smooth and regular and weld metal deposition to achieve full penetration groove weld fused to the base metal throughout joint thickness. Fillet welds, where permitted or required by applicable piping codes, shall achieve adequate depth of fusion of the base metal as required by those codes.
- .4 Brazed joints to use brazing filler and fluxes as specified for each applicable piping system. For socket joints, the tube and joint are to overlapped not less than four times the thickness of the thinner base material, with filter material penetrating to this full depth and finished with well-developed fillet.

3.2 Welded Connections to Existing Pressure Piping Systems

- .1 At the commencement of the Work, where registration and/or inspection of the piping system is required in accordance with provincial boiler and pressure vessel regulations, review with the AHJ (BPV) inspector to determine their weld testing requirements to validate the proposed welding procedures for connecting to existing piping, including but not limited to:
 - .1 acceptable dimensional misalignment between old and new pipe;
 - .2 requirements, if any, for metallurgical analysis of exiting piping;
 - .3 sample butt weld guided-bend test; and
 - .4 sample fillet weld test.
- .2 After testing requirements are determined, provide a proposed schedule for tie-in connections and required existing service shut-down periods, for approval prior to commencing work.
- .3 Prior to shut-down of existing piping systems for tie-ins, inspect the existing pipe O.D. dimensions to confirm their suitability for pipe attachment. Specifically, where the work requires a complete transection of an existing pipe, check the existing pipe for excessive out-of-roundness which would otherwise exceed the allowable misalignment as defined in the applicable ASME piping code. Where necessary, trim the pipe ends in accordance with the referenced piping code.

3.3 Welding Examination

- .1 For piping systems which are specified to be constructed to ASME B31.1 or ASME B31.3, examination of piping, including both visual and other nondestructive examination performed in accordance with those piping codes shall be arranged and paid for by the Contractor, and are to be performed by a specialist testing company whose personnel are qualified to perform such examinations in accordance with ASME BPVC Section V.
- .2 For piping systems which are specified to be constructed to ASME B31.9, examination of piping in accordance with that piping code shall be performed by the Contractor using personnel who are suitably experienced for such examinations.
- .3 Acceptance criteria for weld examination shall be in accordance with the specified ASME piping code applicable to each piping system.

3.4 Welding Inspection

- .1 Arrange and pay for any required inspection of welds by the AHJ (BPV).
- .2 Welders certificates and welding procedures used for the Work to be made available for inspection by the AHJ (BPV) on demand. Provide traceability of welders work by either stamping each weld with the welder's identifying number, or maintain a record log to record and identify each welders work.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

COMMON HANGER AND SUPPORT REQUIREMENTS FOR PIPING

20 05 29

1 GENERAL

1.1 Scope

- .1 Provide hangers and supports for piping.
- .2 The requirements of this specification section apply to all piping systems, except where required otherwise by specific piping specification sections including:
 - .1 21 05 01 for fire protection piping,
 - .2 Division 22 sections for plumbing and drainage piping,
 - .3 22 60 13.70 for medical gas piping,
 - .4 23 11 13 for fuel oil piping,
 - .5 23 11 23 for natural gas piping.
- .3 Provide engineering services associated with the design, analysis and selection of piping supports, including pipe riser supports.

1.2 Related Work

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 16 Flex Connections, Expansion Joints, Anchors and Guides
 - .2 20 05 48 Vibration Isolation
 - .3 20 07 19 Piping Insulation

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Cold piping:** piping with a service temperature at or below 16°C (61°F).
 - .2 **Ambient piping:** piping with a service temperature greater than 16°C (61°F) and up to and including 40°C (104°F).
 - .3 **Hot piping:** piping with a service temperature greater than 40°C (104°F).
 - .4 **Service temperature:** the system fluid maximum operating temperature

1.4 Applicable Codes and Standards

- .1 Product and installation codes and standards:
 - .1 ANSI/MSS SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
 - .2 ULC/ORD-S203 Pipe Hanger Equipment for Fire Protection Service
 - .3 UL 203 Pipe Hanger Equipment for Fire Protection Service
- .2 Refer to each applicable piping specification section for supplemental requirements for pipe supports.

1.5 Design Criteria

- .1 The support spacing and hanger rod size specified herein is based on supporting a single pipe directly from the structure in accordance with MSS SP-58. If multiple pipes are supported from trapeze hangers (or similar), or from common hanger rods supporting a tier of multiple piping, then;
 - .1 the total load on the support rods or similar elements shall not exceed 75% of its published tension load rating data, and
 - .2 a trapeze hanger deflection shall not exceed $1/240^{\text{th}}$ of the support span, and not exceed 60% of the trapeze material yield strength, under all static and dynamic loads.
- .2 Provide complete custom engineered design services in accordance with the requirements of MSS SP-58 for support of vertical piping for the following portions of the Work:
 - .1 vertical piping located in vertical services spaces (shafts) where any of the following criteria apply;
 - (a) piping is NPS 8 and larger,
 - (b) the vertical pipe length exceeds 25 m (82 ft),
 - (c) pipe expansion joints are shown, or
 - (d) vibration isolated supports, variable spring supports or constant load supports are shown.
 - .2 where horizontal piping is supported on;
 - (a) trapeze hangers or supported on/suspended from horizontal structural elements, or
 - (b) pipe racks.
 - .3 submit a materials substitution request in accordance with the requirements of Division 01 for review and approval by the Consultant,
 - .4 all loads used for designing of supports are concurrent static and dynamic loads including vibration, seismic, and where applicable wind and snow loads in outdoor installations,
 - .5 horizontal pipe vertical deflection at midpoint in the pipe span while in operation not to exceed 6.5 mm (0.25 in.),
 - .6 the supported loads are not to exceed the lesser of 80% of manufactured product published load rating data or 60% of the material yield strength for custom fabricated supports,
 - .7 rod hanger loads are not to exceed 80% of the tabulated values in MSS SP-80
 - .8 deflections of horizontal supporting elements does not exceed $1/240^{\text{th}}$ of the span,
 - .9 maximum single point suspended tension load in concrete not to exceed 17 kN (3820 lbs.),
 - .10 operating pipe stress not to exceed the maximum allowable stress in accordance with the requirements of the piping code specified for the piping system.
- .3 Where custom engineered support systems are used, submit shop drawings designed and sealed by a professional engineer licensed in the province of the Work, and include details for each support system including imposed load calculations.

1.6 Submittals

- .1 Submit manufacturer product data sheets for hanger components, and include:
 - .1 load ratings,
 - .2 typical composite detail drawings for complete hanger assembly, including upper attachment, hanger rods, hanger rod swivels, pipe attachments, shields and saddles, and load ratings, for each pipe condition and size.

- .2 Submit support details for glass, fibre-reinforced plastic, and other plastic piping systems which are coordinated with the piping material manufacturer installation instructions.
- .3 Where variable spring supports or constant load supports are shown, provide completely engineered design and fabrication drawings, including any supplementary steel requirements, and loads transferred to the building structure.
- .4 Submit engineered design drawings for fabricated trapeze hangers and completely engineered support systems, including
 - .1 construction detail drawings for each loading condition,
 - .2 span deflection calculations,
 - .3 building attachment load calculations and type.
 - .4 shop drawings to be sealed by a professional engineer licensed in the project location jurisdiction.

1.7 Quality Control

- .1 Where custom engineered supports are used, provide the services of a specialist professional engineer licensed in the location of the Work, to design the support systems and to conduct an inspection of the completed installation that it is in general conformance with the sealed shop drawing requirements, and submit an inspection report to the Owner and the Consultant.

2 PRODUCTS

2.1 General

- .1 Fabricate pipe hangers, supports, sway braces and associated components from stock or production parts, manufactured and fabricated in accordance with MSS SP-58, and the requirements of the piping code specified for each piping system.
- .2 Pipe hangers and supports for fire protection systems to be listed to ULC/ORD-C203 or UL 203, except where such listing requirement is excluded under applicable NFPA standards.
- .3 Select elements of pipe support systems to provide adequate factors of safety under loads applied by gravity, by temperature induced expansion and contraction, by internal pressure in mechanically jointed plain end pipe, and by fluid flow pressure thrust.
- .4 Product finishes (unless otherwise specified for each product):
 - .1 outdoors: hot dipped galvanized,
 - .2 in mechanical service rooms, pipe tunnels and pipe trenches: hot-dipped galvanized,
 - .3 other indoor locations: plain finish, zinc plated, or painted finish.
 - (a) exception: do not use any zinc coated or electro-plated products in data center rooms.
- .5 Pipe support products to be selected from manufacturers standard product line.

Standard of Acceptance

- Anvil
- Unistrut
- Taylor
- Acrow Richmond
- Portable Pipe Hangers
- Hilti
- nVent Caddy
- Pipe Shields

2.2 Upper Attachments – Concrete Inserts

- .1 For new cast-in-place concrete.
- .2 Concrete inserts –wedge type;
 - .1 single hanger support,
 - .2 galvanized wedge inserts to MSS SP-58 type 18.
 - .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8.
 - .4 maximum tension load rating: 4.4 kN (1000 lbs.),
 - (a) single rod support, for pipes NPS 6 and smaller,
 - (b) double rod support, for pipes NPS 10 and smaller,

Standard of Acceptance

- Anvil - fig. 281
- Unistrut - fig. P-3245
- Taylor - fig. 81

- .3 Concrete inserts – tapped coil type;
 - .1 single hanger support,
 - .2 plated carbon steel insert, tapped coil design, with flat washer base and closed ferrule,
 - .3 constructed to receive tapped bolts or rods, or with manufacturer lag bolts.
 - .4 maximum tension load rating: 15.0 kN (3375 lbs.) within 125 mm (5 in.) of nearest concrete edge.
 - (a) single rod support, for pipes NPS 8 and smaller,
 - (b) double rod support, for pipes NPS 12 and smaller.

Standard of Acceptance

- Acrow Richmond – fig. LF-W

- .4 Concrete inserts –iron cross type;
 - .1 single hanger support,
 - .2 stainless steel body with two 300 mm (12 in.) long fiberglass reinforcing rods in a cross-pattern, to MSS SP-58 type 18,
 - .3 body reinforcing rods tied to concrete rebar,
 - .4 maximum tension load rating: 26.2 kN (5,900 lbs.) based on rod size,
 - (a) single rod support, for pipes NPS 14 and smaller,
 - (b) double rod support, for pipes NPS 24 and smaller,

Standard of Acceptance

- Anvil - fig. 286
- Unistrut - fig. P-3246

- .5 Concrete inserts – channel type;
 - .1 single hanger or multiple hangers support,

- .2 12 Ga channels, hot-dipped galvanized, with concrete embedment tabs, open bottom channel allowing multiple support points and lateral position adjustment,
- .3 with back plates, end caps and closure strips to prevent concrete spillage into channel space,
- .4 minimum point load spacing: 300 mm (12 in.)
- .5 maximum tension load rating:
 - (a) 200 mm (8 in) channel: 4.4 kN (1000 lbs.)
 - (b) 300 mm (12 in) channel: 6.6 kN (1500 lbs.)
 - (c) 450 mm (16 in) and longer channels: 28.8 kN/m (2000 lbs./ft), but not less than 17.8 kN (4000 lbs.),

Standard of Acceptance

- Unistrut - fig. P-3249 to P-3270 series.

2.3 Upper Attachments – Existing Concrete

- .1 Surface mount on existing concrete:
 - .1 surface mount clevis plate, for mounting to concrete,
 - .2 carbon steel plate with clevis and malleable iron socket with bolt, and weldless eye nut.

Standard of Acceptance

- Anvil - fig. 49 clevis plate, Fig. 290 weldless eye nut
- Taylor - fig. 166 clevis plate, Fig. 64 weldless eye nut

- .2 Piping or equipment supported from existing concrete construction:
 - .1 threaded inserts for drilled holes.

Standard of Acceptance

- Hilti - fig. HDI, Kwick Bolt, HSL

2.4 Upper Attachments – Steel Structure

- .1 Steel beam (bottom flange) - for cold and ambient piping NPS 2 and smaller:
 - .1 malleable iron or carbon steel, symmetrically loading beam clamp to MSS SP-58, type 30,
 - .2 listed to ULC/ORD-C203 or UL 203 for fire protection piping.

Standard of Acceptance

- Anvil - fig. 218
- Taylor - fig. 410

- .2 Steel beam (bottom flange) - for cold and ambient piping NPS 2½ and larger, and hot piping:
 - .1 forged steel, symmetrically loading heavy duty beam clamp, to MSS SP-58, type 28 or 29.
 - .2 with weldless eye nut when used with clevis supports.
 - Anvil - fig. 228 or 292
 - Taylor - fig. 450

- .3 Steel beam (top flange) - for conduit, piping NPS 2 and smaller, and ductwork:

- .1 carbon steel, hook rod with locking jaw, fasteners and lock washers, to MSS SP-58, type 25,
- .2 listed to ULC/ORD-C203 or UL 203 for fire protection piping.

Standard of Acceptance

- Anvil - fig. 227
- Taylor

- .4 Steel joists (lower chord) – for cold and ambient piping NPS 2 and smaller:

- .1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints,
- .2 carbon steel washer plate with locking nuts on top-side of washer,
- .3 second steel washer plate on underside of joist with nut.

Standard of Acceptance

- Anvil - fig. 60
- Taylor - fig. 80

- .5 Steel joists (lower chord) – for cold and ambient piping NPS 2½ and larger, and hot piping:

- .1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints,
- .2 carbon steel washer plate with double locking nuts on top-side of washer, with carbon steel welded beam clevis attachment, and forged steel weldless eye nut.

Standard of Acceptance

- Anvil - fig. 60 with fig. 66 and fig. 290.
- Taylor - fig. 66 and fig. 64.

2.5 Upper Attachments – Wall Brackets

- .1 Medium and heavy-duty wall mounting brackets:

- .1 welded carbon steel plate or channel assembly, designed to allow at least 75 mm (3 in.) of horizontal adjustment of hanger rod position, to MSS SP-58, Types 32 and 33,
- .2 carbon steel backplates for through bolting of concrete walls where required by supported load and wall material,
- .3 for bolting into concrete wall, concrete block, or welding to building structure (where permitted by structural engineer).

Standard of Acceptance

- Anvil - fig. 195 and 199
- Taylor - fig. 801 and 802.

- .2 Light-duty wall mounting brackets:

- .1 welded carbon steel plate or channel assembly, single point rod support, to MSS SP-58, Types 31,
- .2 with carbon steel backplates for through bolting of concrete walls where required by supported load,

- .3 FM approved,
- .4 for bolting into concrete wall, concrete block, or welding to building structure,

Standard of Acceptance

- Anvil - fig. 194
- Taylor

2.6 Upper Attachment - Swivels

.1 Clevis swivel:

- .1 to allow rotation movement of suspended clevis hangers,
- .2 forged steel clevis with hanger pin, threaded rod socket, to MSS SP-58 type 14,
- .3 tension load capacity not less than the connected rod load capacity,
- .4 threaded end connected to concrete insert, with clevis end connected to weldless eye nut or welded eye rod.

Standard of Acceptance

- Anvil - fig. 299
- Taylor - fig. 63

.2 Weldless eye nut swivel:

- .1 to allow rotation movement of suspended clevis hangers,
- .2 forged steel eye nut, threaded rod socket, to MSS SP-58 type 17,
- .3 tension load capacity not less than the connected rod load capacity.
- .4 for connection to top of rod hanger, suspended from a clevis.

Standard of Acceptance

- Anvil - fig. 290
- Taylor – fig. 64

2.7 Hanger Rod

.1 Continuous threaded rod:

- .1 carbon steel, USS national course thread,
- .2 tension load ratings to MSS SP-58,

Standard of Acceptance

- Anvil - fig. 146
- Taylor – fig. 54

.2 Welded eye rod:

- .1 carbon steel, USS national course thread,
- .2 tension load ratings to MSS SP-58,
- .3 tension load rating to be the same as continuous welded rod.

Standard of Acceptance

- Anvil - fig. 278
- Taylor

2.8 Horizontal Pipe Support – Pipe Roller

.1 Suspended support - adjustable:

- .1 adjustable, trapeze or yoke style, pipe roller support to MSS SP-58, type 41 or 43.

Standard of Acceptance

- Anvil - fig. 171 or fig. 181
- Taylor – fig. 95 or fig. 93

.2 Bottom support - adjustable:

- .1 adjustable pipe roller with bottom support rods, to MSS SP-58, type 41.
- .2 with mounting rods and upper/lower retention nuts at both ends.

Standard of Acceptance

- Anvil Fig. 177
- Taylor – fig. 95S

.3 Bottom support – pipe roll stand:

- .1 cast iron pipe roller with drilled cast iron stand, to MSS SP-58, type 44,
- .2 fixed base and adjustable base.

Standard of Acceptance

- Anvil - fig. 271 (fixed), fig. 274 (adjustable)
- Taylor – fig. 279S (fixed), fig. 280S (adjustable)

2.9 Horizontal Pipe Support – Clevis

.1 Clevis support:

- .1 carbon steel, adjustable clevis, with yoke bolt reinforcing tube, to MSS SP-58 Type 1,
- .2 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
- .3 sized for outside dimension of pipe and insulation,
- .4 nominal pipe size:
 - (a) steel pipe: NPS ½ to NPS 30
 - (b) ductile or cast iron pipe: NPS 3 to 24

Standard of Acceptance

- Anvil - fig. 260
- Anvil - fig. 590 (for ductile or cast iron pipe)
- Taylor – fig. 24
- Taylor – fig. 27AC (for ductile or cast iron pipe)

.2 Clevis support with integral non-metallic insulation saddle:

- .1 carbon steel, adjustable clevis to MSS SP-58, type 1, ULC listed, with yoke bolt reinforcing tube,

- .2 with glass-reinforced polypropylene saddle, sized to allow up to 50 mm (2 in.) insulation thickness,
- .3 sized for outside dimension of pipe and insulation,
- .4 nominal pipe size: NPS ¾ to NPS 6,
- .5 piping system design temperature limits: 4.4 to 93°C (40 to 200°F).

Standard of Acceptance

- Anvil - fig. 260 ISS

.3 Clevis support for copper pipe and tube:

- .1 carbon steel yoke and clevis, adjustable clevis to MSS SP-58, type 1, copper plated or felt lined finish,
- .2 nominal pipe size: NPS ½ to NPS 4,
- .3 sized for outside dimension of pipe/tube, or outside diameter of pipe and insulation as applicable.

Standard of Acceptance

- Anvil - fig. CT-65 or 260F
- Taylor – fig. 52

.4 Light-duty, side-opening clevis support:

- .1 for fire protection service only,
- .2 galvanized carbon steel, adjustable clevis with fixed yoke,
- .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
- .4 sized for outside dimension of pipe (and insulation if applicable).
- .5 sized for outside dimension of pipe (and insulation where applicable),
- .6 nominal pipe size: NPS 2 to NPS 8.

Standard of Acceptance

- Hilti - fig. MH-SLC Speed Lock

2.10 Horizontal Pipe Support – Slides

.1 Sliding pipe base supports – welded attachment:

- .1 Tee or H shaped pipe support for welding to pipe, to allow axial and lateral movements,
- .2 carbon steel, structural shape or fabricated, to ANSI/MSS SP-58 Type 35,
- .3 PTFE bonded to underside of slide,
- .4 matching lower steel plate with bonded PTFE element (for fastening to structural support beam),
- .5 operating temperature range: -28 to 200°C (-20 to 400°F),
- .6 pipe guide variants:
 - (a) lug restraints to limit lateral movement to 1.6 mm (1/6 in) or 25 mm (1 in),
 - (b) lug restraints to limit uplift movement to 1.6 mm (1/6 in),
- .7 nominal pipe size: NPS ½ to NPS 30.

Standard of Acceptance

- Anvil - figs. 257, 436, 439
- Taylor – fig. 257, 436, 439

2.11 Horizontal Pipe Support – Swivel Ring Hanger

- .1 For non-insulated stationary piping and tubing only.
- .2 Pipe swivel ring hangers:
 - .1 carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,
 - .2 copper plated or epoxy-coated for use on copper tubing,
 - .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
 - .4 nominal pipe size: NPS ½ to NPS 4.

Standard of Acceptance

- Anvil - fig. 69, CT-69
- Taylor – fig. 41, 43

2.12 Horizontal Pipe Support – Trapeze

- .1 Manufactured trapeze support:
 - .1 load ratings as per manufacturers data sheets,
 - .2 carbon steel, double-C channel (strong-backs), HSS shape and equal-leg angles.
- ### *Standard of Acceptance*
- Anvil - fig. 45, 46, and 50
 - Taylor – fig. 170
- .2 Fabricated trapeze support:
 - .1 designed and sealed by a professional engineer licensed in the jurisdiction of the work.
 - .2 performance:
 - (a) maximum deflection between supports: 1/250 (0.4%) of span
 - (b) minimum factor of safety: five (5) times load to ultimate tensile or compressive strength, but not to exceed 60% of yield strength.
 - .3 carbon steel shapes, to suit load application,
 - (a) hollow steel section,
 - (b) equal leg EI section, or
 - (c) double C channel “strong-back”, with welded clips.
 - .3 Hanger rods:
 - .1 minimum of two support rods per trapeze,
 - .2 rods selected for minimum factor of safety of 4 times load for tensile or compressive strength of the rod.
 - .4 Pipe restraint:
 - .1 restrain pipes from lateral movement with:
 - (a) bolt-on angle brackets or pipe U-bolts for manufactured hangers,
 - (b) welded-on angles for fabricated hangers,

- .2 restraints to permit axial linear movement and axial-rotation, except where otherwise shown to be a guide or an anchor.

2.13 Horizontal Pipe Support – Drainage MJ

- .1 For horizontal cast iron drainage piping, as an alternative to clevis hangers.
 - .1 carbon steel, plain finish,
 - .2 pipe size: NPS 2 to NPS 6

Standard of Acceptance

- Anvil - fig. 250
- Taylor – fig. 25

2.14 Vertical Pipe Stanchions

- .1 Pipe support stanchion, with welded attachment:
 - .1 fixed height, or telescoping two-piece design with height adjustment, field-welded to pipe elbow or horizontal pipe,
 - .2 carbon steel, structural cylinder shape,
 - .3 designed for static loads of pipe and contents, as well as dynamic loads and anchor loads as shown,
 - .4 nominal pipe size: NPS 2 to NPS 18.

Standard of Acceptance

- Anvil - fig. 62
- Taylor

2.15 Vertical Pipe Riser Clamps

- .1 Steel pipe, cast iron pipe:
 - .1 carbon steel clamps for carbon steel piping and cast iron piping,
 - .2 stainless steel clamps for stainless steel piping,
 - .3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
 - .4 supplied with field-welded pipe support lugs of same material as supported steel pipe (not including cast iron pipe).
 - .5 floor supported pipe riser clamps, to ANSI/MSS SP-58, type 8,

Standard of Acceptance

- Anvil - fig. 261
- Taylor – fig. 82

- .6 suspended pipe riser clamps, 4 or 6 bolt patterns, to ANSI/MSS SP-58, type 42,

Standard of Acceptance

- Anvil - fig. 40, 40SS
- Taylor – fig. 82HCopper pipe and tube:

- .7 floor supported pipe riser clamps, carbon steel with copper plated finish, to ANSI/MSS SP-58, type 8,

Standard of Acceptance

- Anvil - fig. CT-121
- Taylor – fig. 85

2.16 Vibration Isolation Supports

- .1 Refer to specification section 20 05 48.

2.17 Cast Iron Pipe Joint Restraint

- .1 Joint restraint rodding assembly for cast iron and asbestos cement drain waste and vent pipe, for each branch, tee, wye and clean-out fittings on drainage piping NPS 5 and over.
- .2 Clamp and rod joint restraint:
 - .1 carbon steel pipe clamps with four bolt fasteners and rod washers, plain finish, to MSS SP-58, Type 8,
 - .2 carbon steel threaded rods and load nuts,
 - .3 two pipe clamps and two restraint rods required for each joint.

Standard of Acceptance

- Taylor – fig. 35

2.18 Saddles and Shields at Pipe Supports

- .1 Insulation shields:
 - .1 galvanized steel protection shield, thickness and length as applicable to pipe size, to MSS SP-58 type 40.

Standard of Acceptance

- Anvil - fig. 167 (up to NPS 24)
- Anvil - fig. 168 - Riblok (up to NPS 8)
- Taylor – fig. 69 or 69H

- .2 Pipe saddles:

- .1 Carbon steel or stainless steel (to match pipe material) saddle welded to pipe with insulation inserted between saddle and pipe, to MSS SP-58 type 39.

Standard of Acceptance

- Anvil - fig. 160 to 166
- Taylor – fig. 70 to 77

2.19 Rooftop Supports

- .1 Prefabricated rooftop pipe and conduit supports, supported without penetrations of the roof membrane or flashings:
 - .1 to ANSI/MSS SP-58, Type 62, 63 and 64,
 - .2 high density polypropylene roof bases, with UV protection,
 - .3 roof pads suitable for roof type,
 - .4 minimum 2.5 mm (12 ga) formed channel structure

- .5 minimum 1.9 mm (14 ga) supplementary support
- .6 galvanized steel pipe support mounting channels,
- .7 clevis or roller pipe support as required by pipe service specified herein,
- .8 modular mounting channels and clips for conduit,
- .9 for pipe size: NPS ½ to NPS 12.
- .10 for conduit Ø12 mm to Ø100 mm.

Standard of Acceptance

- Portable Pipe Hangers
- Miro (Unistrut)
- Taylor Pipe Supports

3 EXECUTION

3.1 General

- .1 Where the specific requirements for pipe supports are specified in other sections of Division 20 to 23, the requirements of those sections take precedence over the requirements of this specification section.

3.2 Coordination with Concrete Work

- .1 Supply and deliver concrete inserts to site in ample time to be built into the work of Division 03.
- .2 Correctly position and set concrete inserts onto concrete formwork for pipes and equipment hangers. Secure inserts firmly to formwork before concrete is poured.
- .3 Do not use explosive drive pins in any section of the Work without obtaining prior approval from the Consultant.

3.3 Horizontal Pipe Support Spacing and Hanger Rod Size

- .1 Provide horizontal pipe supports at the spacing and hanger rod size as detailed in the following tables, unless specified otherwise in other sections of Division 20 to 23:
 - .1 carbon steel, galvanized steel, and stainless steel pipe;
 - (a) schedule 20 to schedule 80 inclusive: to Table 1A.
 - .2 stainless steel pipe: schedule 10S: to Table 1B
 - .3 copper tube, stainless steel tube: to Table 1C.

Table 1A: Horizontal Pipe Support Spacing for Carbon Steel, Galvanized Steel, Stainless Steel Piping Standard Weight, Schedule 20 to 80 Inclusive			
Pipe Size NPS	Rod Diameter	Maximum Spacing, Liquids m, (ft)	Maximum Spacing Steam, Gases [Note 1] m (ft)
½	M10 (3/8 in)	1.8 (6)	1.8 (6)
¾ to 1¼	M10 (3/8 in)	2.1 (7)	2.1 (7)
1½	M10 (3/8 in)	2.7 (9)	2.7 (9)
2	M10 (3/8 in)	3.0 (10)	4.0 (13)
2½	M12 (½ in)	3.3 (11)	4.3 (14)
3	M12 (½ in)	3.3 (12)	4.6 (15)
4	M16 (5/8 in)	4.2 (14)	5.2 (17)
6	M20 (¾ in)	5.1 (17)	6.4 (21)
8	M20 (¾ in)	5.7 (19)	7.3 (24)
10	M20 (7/8 in)	6.7 (22)	7.9 (26)
12	M20 (7/8 in)	7.0 (23)	9.1 (30)
14	M24 (1 in)	7.5 (25)	9.8 (32)
16	M24 (1 in)	8.0 (27)	10.7 (35)
18	M24 (1 in)	8.4 (28)	11.3 (37)
20	M30 (1-1/4 in)	9.0 (30)	11.9 (39.0)
24	M36 (1-1/2 in)	9.6 (32)	12.8 (42.0)

Notes:

[1] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the "liquids" values.

Table 1B: Horizontal Pipe Support Spacing for Schedule 10S Stainless Steel Pipe		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	2.1 m (6.7 ft)
¾	M10 (3/8 in)	2.4 m (7.7 ft)
1	M10 (3/8 in)	2.8 (9.0)
1-1/4	M10 (3/8 in)	3.2 (10.3)
1½	M10 (3/8 in)	3.2 (10.3)
2	M10 (3/8 in)	3.6 (11.6)
2½	M10 (3/8 in)	4 (12.8)
3	M10 (3/8 in)	4.3 (13.8)
4	M12 (1/2 in)	4.7 (15.1)
6	M12 (1/2 in)	5.4 (17.3)
8	M16 (5/8)	5.9 (18.9)
10	M16 (5/8)	6.5 (20.9)
12	M16 (5/8)	7 (22.5)
14	M20 (3/4)	7.0 (22.5)
16	M20 (3/4)	7.3 (23.4)
18	M20 (3/4)	7.5 (24.1)
20	M24 (1)	8.0 (25.7)
24	M24 (1)	8.6 (27.6)

Table 1C: Horizontal Pipe Support Spacing for Copper Tube, and Stainless Steel Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .2 Hanger spacing and hanger rod diameter for steel pipe or copper tube with flexible roll groove joints;
 - .1 to be as shown in the above tables for the appropriate pipe material, with not less than one hanger between joints, and
 - .2 provided with anchors and guides located to maintain piping true to line and grade.
- .3 Support plastic and other special piping, including anchors and guides, in accordance with the pipe manufacturer's requirements.

3.4 Horizontal Pipe Hanger and Support Selection

- .1 For fire protection piping;
 - .1 use clevis hangers for all pipe sizes,
 - .2 swivel ring pipe hangers may be used for fire protection piping NPS 4 and smaller.
- .2 Swivel ring pipe hangers may only be used for;
 - .1 drain waste and vent (DWV) piping and tubing, NPS 4 and smaller,
 - .2 medical gas piping and laboratory gas piping, NPS 4 and smaller,
 - .3 compressed air piping and tubing located downstream of a refrigerated dryer, NPS 2 and smaller,
 - .4 chemical treatment piping NPS 2 and smaller
- .3 For cast iron drainage and vent piping;
 - .1 use clevis hangers for suspended supports,
 - .2 drainage MJ type hangers may be used on hub-less cast iron piping,
 - .3 use roller or slide type supports for bottom supported piping. For slide supports, use a variant incorporating pipe band clamps in lieu of welded attachment.
- .4 For other piping, select pipe support types in accordance with the following:

- .1 STEP 1: select basic support type based on piping design service temperature and distance between adjacent pipe anchors as shown in
 - (a) Table 2A for carbon steel and galvanized steel pipe, and
 - (b) Table 2B for copper tube and stainless steel pipe and tube.
- .2 STEP 2: apply restrictions on support types in accordance with Table 3 where the support rod length between the structure and the support element is 300 mm (12 in) or less, and
- .3 STEP 3: apply restrictions on support type based on pipe size in accordance with Table 4.

Table 2A Carbon Steel and Galvanized Steel Pipe								
Piping Heat Type	Pipe System Maximum Operating Temperature		Pipe Run Distance Between Anchors m (ft)					
	°C	(°F)	5 (15)	10 (33)	15 (49)	20 (65)	25 (82)	30 (100)
Cold	≤16	(≤61)						
Ambient	20	(68)						
	30	(86)						
Hot	40	(104)			Clevis,			
	50	(122)			Trapeze,			
	60	(140)			Roller, or			
	70	(158)			Slide			
	80	(176)						
	90	(194)						
	100	(212)						
	120	(250)						
	150	(302)						Roller or Slide
	200	(392)						
	250	(482)						

Table 2B Copper Tube, and Stainless Steel Pipe and Tube								
Piping Heat Type	Pipe System Maximum Operating Temperature		Distance Between Anchors m (ft)					
	°C	(°F)	5 (15)	10 (33)	15 (49)	20 (65)	25 (82)	30 (100)
Cold	≤16	(≤61)						
Ambient	20	(68)						
	30	(86)						
Hot	40	(104)			Clevis,			
	50	(122)			Trapeze,			
	60	(140)			Roller,			
	70	(158)			Slide			
	80	(176)						
	90	(194)						
	100	(212)						
	120	(180)						
	150	(302)						
	200	(392)						
	250	(482)						

Table 3 Restrictions on Selection of Support Type For Hanger Rod Lengths ≤ 300 mm (12 in)	
Pipe Service	Restriction
Cold Piping	Clevis hangers not permitted for pipe size NPS 8 and larger
Hot Piping	Clevis hangers not permitted for pipe sizes NPS 2-1/2 and larger; for pipe size NPS 2 and smaller the clevis must be placed outside of pipe insulation.

The following abbreviations apply to Table 4.

- CL Clevis hanger
- CL(Sa) Clevis hanger with integral polypropylene saddle
- RL Roller support
- SD(T) Slider, T shape
- SD(H) Slider, H shape
- TZ Trapeze
- Permitted use

Table 4 Restrictions on Selection of Support Type Based on Pipe Size (except cast iron drainage pipe)						
Pipe Size	Support Type					
	CL	CL(Sa)	RL	SD(T)	SD(H)	TZ
¾ - 4	●	●	●	●		●
6	●	●	●	●	●	●
8	●		●	●	●	● [1]
10 – 14	●			●	●	● [1]
16-18				●	●	● [1]
20 – 24					●	● [1]

Notes:

[1] When used in conjunction with a slide support.

- .4 For pipe size NPS 16 to 24, a clevis hanger may be used to support a concentrated load, provided it is used only to support the concentrated load and there is a separate pipe run support within one-third of the maximum allowable span on each side of the concentrated load.

3.5 Vertical Pipe Supports

.1 Pipe riser clamps:

- .1 provide pipe riser clamps for pipes NPS 4 and smaller at every second floor level for vertical pipe risers passing through two or more floors, unless other vertical pipe support types are shown,
- .2 for steel pipe, provide support lugs welded to steel piping so that pipe lugs bear on the top-surface of the riser clamp,
- .3 for copper tube and pipe, arrange vertical piping so that a pipe joint bears on the top-surface of the riser clamp.

.2 Fabricated pipe riser supports:

- .1 Support piping NPS 6 and larger, using fabricated riser support brackets complete with reinforcing gusset plates welded to piping, designed not to exceed the maximum allowable local pipe stress at a load of not less than 200% of the supported load of:
 - (a) for the lowest support point of the riser, the supported pipe plus insulation weight for the lowest support interval plus the total water weight of the entire riser.
 - (b) except at the lowest support point of the riser, the pipe plus insulation weight for each support interval (except at the bottom of the riser).

- .3 Support vertical cold piping and hot piping for riser heights that are 25 m (82 ft) or less in height as follows:
 - .1 provide spring vibration isolators in accordance with specification section 20 05 48, attached to pipe riser supports at intervals of every 2nd storey or 10 m (32 ft), whichever is less,
 - .2 provide a pipe anchor at the base of the riser or the mid-height of the riser.
- .4 Support vertical cold piping and hot piping for riser heights that are greater than 25 m (82 ft) but do not exceed 50 m (165 ft) in height as follows:
 - .1 provide a custom engineered support system utilizing variable spring isolators,
 - .2 provide pipe anchors at the mid-point of the riser, and
 - .3 provide at least one spring support per riser section.
- .5 Support vertical cold piping and hot piping for riser heights greater than 50 m (165 ft) as follows:
 - .1 provide a custom engineered support system utilizing constant load supports for each pipe section located between expansion joints,
 - .2 variable spring supports may be used at intermediate locations between main constant load supports,
 - .3 provide pipe anchor supports at the base of the riser, and at intermediate locations along riser length as necessary,
 - .4 provide in-line expansion joints between each pair of pipe anchors on the same riser,
 - .5 design pipe anchors to withstand pressure thrust created by the expansion joints, unless pressure-balanced expansion joints are used,
- .6 Where custom engineering riser supports are required, they are to be designed to meet the following criteria:
 - .1 the maximum vertical movement of a horizontal branch pipe is not to exceed 20 mm (0.75 in) from its installation temperature to its in-service temperature,
 - .2 the maximum vertical movement of the horizontal mains pipe at the base or top of the riser is not to exceed 40 mm (1.5 in.) from its installation temperature to its in-service temperature, provided that the horizontal piping adjacent to the riser are also supported on variable spring supports for the first three horizontal support points.

3.6 Support and Hanger Installation

- .1 Support piping directly from or on structural building elements. Do not support pipe directly from other services.
- .2 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete installation.
- .3 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.
- .4 Do not support piping or tubing in direct contact with hangers or supports of dissimilar metallic material.
- .5 Coordinate location of pipe supports with pipe flexible connectors, pipe guides and pipe anchors provided under specification section 20 05 16.
- .6 In steel framed construction, support piping from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;

- .1 fabricate supplementary steel from standard HSS sections, single EL section, double C “strongback” sections, or pipe rolls,
- .2 size supporting steel to limit span deflection to 1/250 (0.4%) between support points,
- .3 mechanically fasten supplementary steel to structural steel.
- .7 Offset hangers so that rods are within 4° of vertical when in the operating position.
- .8 Provide a pipe support within 300 mm (12 in.) of;
 - .1 an elbow or tee,
 - .2 a concentrated load, including but not limited to valves, strainers and flanges,
 - .3 a connection to equipment.
- .9 Where hanger rods are used, provide load nuts on top and underside of attachment to the pipe support, including clevis hangers, roll supports, roll yoke hangers, and trapeze hangers.

3.7 Clevis Hangers

- .1 Where clevis hangers are used for cold- or hot-piping,
 - .1 select clevis to fit the outside dimension of pipe and insulation,
 - .2 provide hanger rods with a clevis swivel and weldless eye nut at the building attachment connection, to allow free-rotation movement of the hanger rod in the same direction as axial movement of the associated pipe.
- .2 Where clevis hangers are used for stainless steel pipe or tube and for copper tube;
 - .1 use copper or epoxy finished clevis hangers for copper pipe/tube,
 - .2 use stainless steel or alloyed steel clevis hangers (for stainless steel pipe/tube), or
 - .3 use a standard clevis hanger with integral non-metallic insulation saddles and hangers are sized for outside of the pipe and insulation.
- .3 Where the project requires seismic bracing of piping systems, add a Schedule 40 pipe over the clevis bolt, sized to provides at least 6 mm (1/4 in.) inside diameter clearance to the clevis bolt. This applies only where a transverse or longitudinal brace is attached to the clevis hanger.

3.8 Trapeze Hangers

- .1 Provide shim pipes on common trapeze hangers to slope each pipe in required direction, and mechanically fasten or tack-weld shim plates to the trapeze hanger,
- .2 Provide U-bolts or fabricated angles to restrict lateral pipe movement; while allowing pipe thermal axial motion and rotation;
 - .1 fasten U-bolts or angles to the trapeze hanger,
 - .2 fabricated angles to extend vertically at least one-quarter the outside pipe/insulation diameter,
 - .3 where seismic restraint is required, only use U-bolts.

3.9 Pipe Saddles and Shields

- .1 Provide pipe saddles and shields for insulated piping in accordance with the following table 5:

Table 5: Insulation Hanger Protection				
Pipe Service	Service Temperature °C (F)	Pipe Size NPS	Pipe Saddle	Insulation Shield [Note 1]
Hot Piping	> 93 to ≤ 205 (> 200 to ≤ 400)	≥ 1-1/2	Yes	---
		≤ 1-1/4	---	Yes
	> 60 to ≤ 93 (> 140 to ≤ 200)	> 6	Yes	---
		≥ 1-1/2 and ≤ 6	---	Yes
		≤ 1-1/4	---	Yes
	> 40 to 60 (≥ 104 to ≤ 140)	≥ 1-1/2	---	Yes
		≤ 1-1/4	---	Yes
Ambient Piping (Insulated)	> 16 to ≤ 40 (> 60 to ≤ 104)	All	---	Yes
Cold Piping	≤ 16 (60)	≥ 1-1/2	---	Yes
		≤ 1-1/4	---	Yes

Notes:

[1] Refer to specification section 20 07 19 for high density insulation insert requirements.

- .2 Provide pipe shields for uninsulated glass and plastic piping NPS 1-1/2 and larger.
- .3 Where piping is insulated and requires pipe shields, install the shields between pipe insulation and pipe support. Provide high-density insulation insert between pipe and insulation shields in accordance with specification section 20 07 19.
- .4 Where piping is not insulated and requires a pipe shield, install the shields between the pipe and the pipe support.
- .5 Where clevis hangers with integral insulation saddles are used, apply insulation sealant to the polypropylene saddle in accordance with the pipe hanger manufacturer's instructions;
 - .1 for hot piping, coordinate with the pipe insulation contractor to apply sealant coating to the integral saddle at the time pipe insulation is installed,
 - .2 for cold piping, seal the saddle's pipe contact surfaces with vapour-barrier sealant before the piping is installed. Finish sealing the remainder of the saddles' exposed faces when pipe insulation is installed.

3.10 Rooftop Supports

- .1 Install rooftop supports in accordance with the manufacturer's instructions.
- .2 Notwithstanding general pipe support spacing specified herein or in other specification sections, select the size and provide the quantity of rooftop pipe and conduit supports so that the applied gravity (deadweight) load including pipe, insulation and fluid media contents, to the roof does not exceed the greater of 35 kPa (5 psi) compressive load or 50% of the roofing system maximum allowable compressive load, whichever is less.
- .3 Rooftop supports may be used to support both piping and electrical conduit, provided the combination of loads does not exceed the manufacturer's service limits.
- .4 Provide roofing pads for each pipe/conduit support base, of the type required to suit the roofing membrane or insulation.

- .5 Use clevis or roller hanger based on pipe service requirements specified herein. For gas piping, only use roller supports with integral top-restraint arm.

3.11 Vibration Isolation Supports

- .1 Provide vibration isolators at pipe supports for horizontal piping in accordance with specification section 23 05 48.
- .2 Provide vibration isolators at vertical pipe (riser) supports in accordance with specification section 20 05 48.
- .3 When installed with clevis hangers, install the vibration isolators below and separate from the upper attachment clevis; do not use the vibration isolator for the purpose of rotation movement of the support rod.

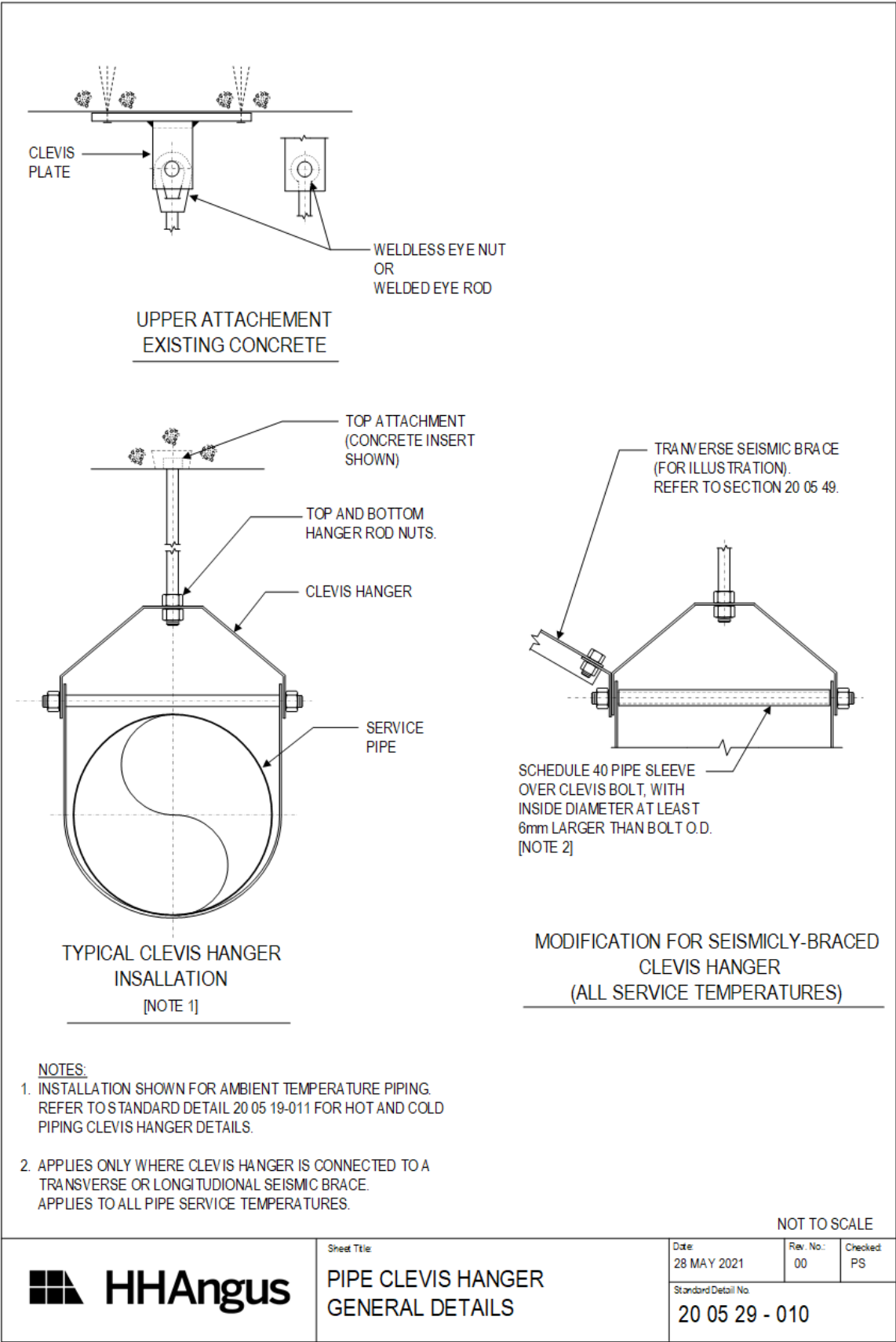
3.12 Set-up After Installation

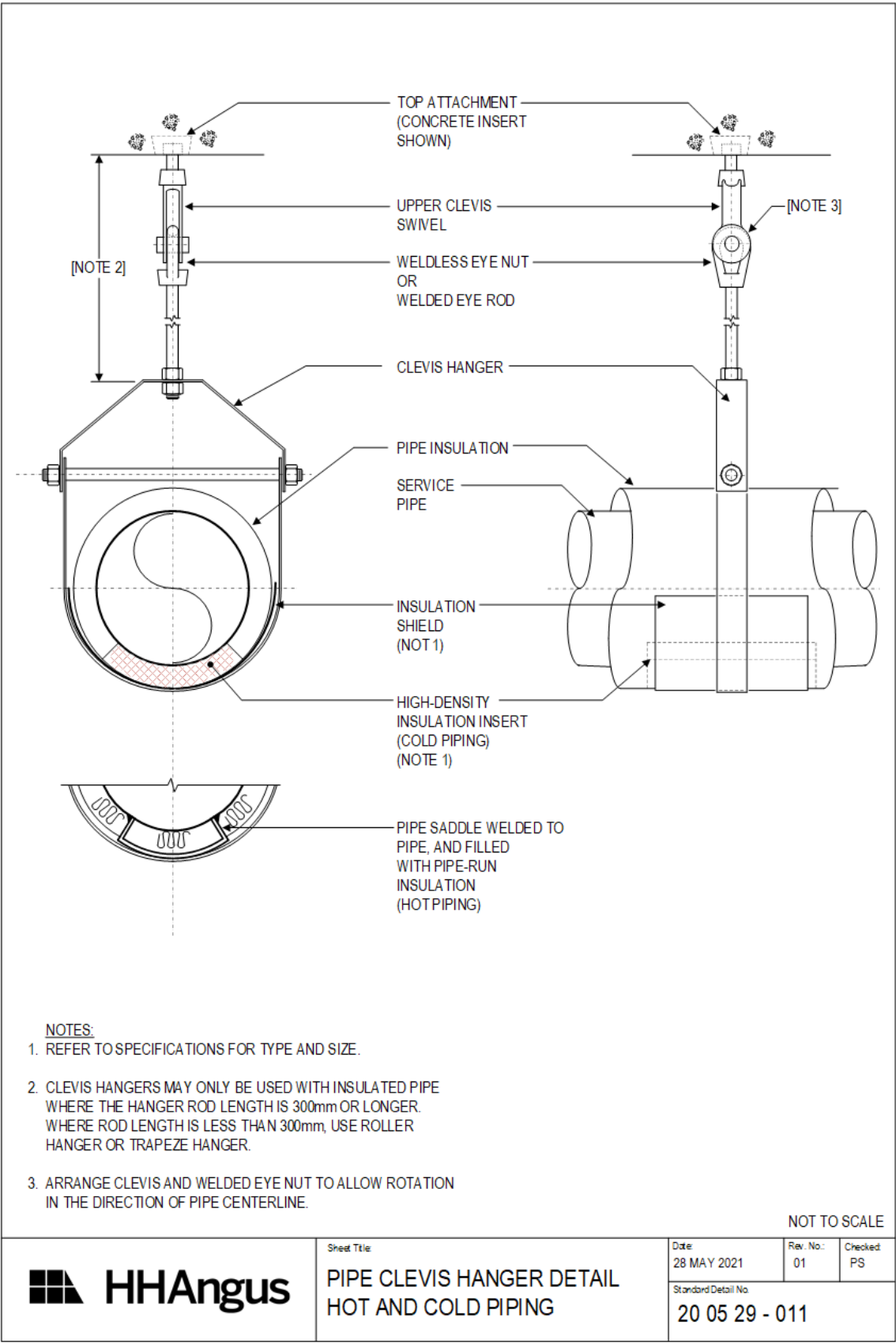
- .1 Adjust hangers to equalize hanger loads, to support piping true to line and grade, and to minimize loads transferred through connections to equipment and outlets.

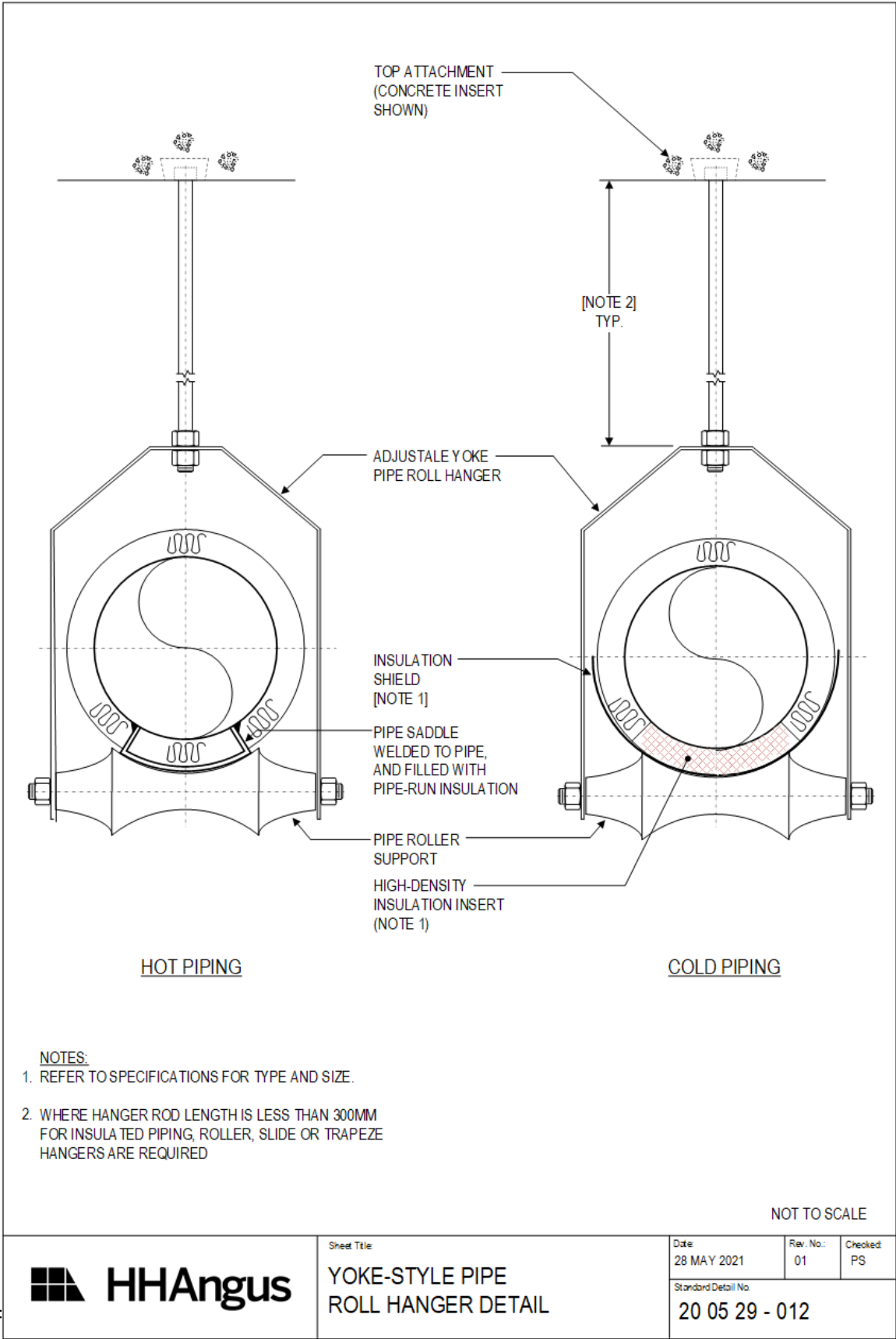
3.13 Standard Details

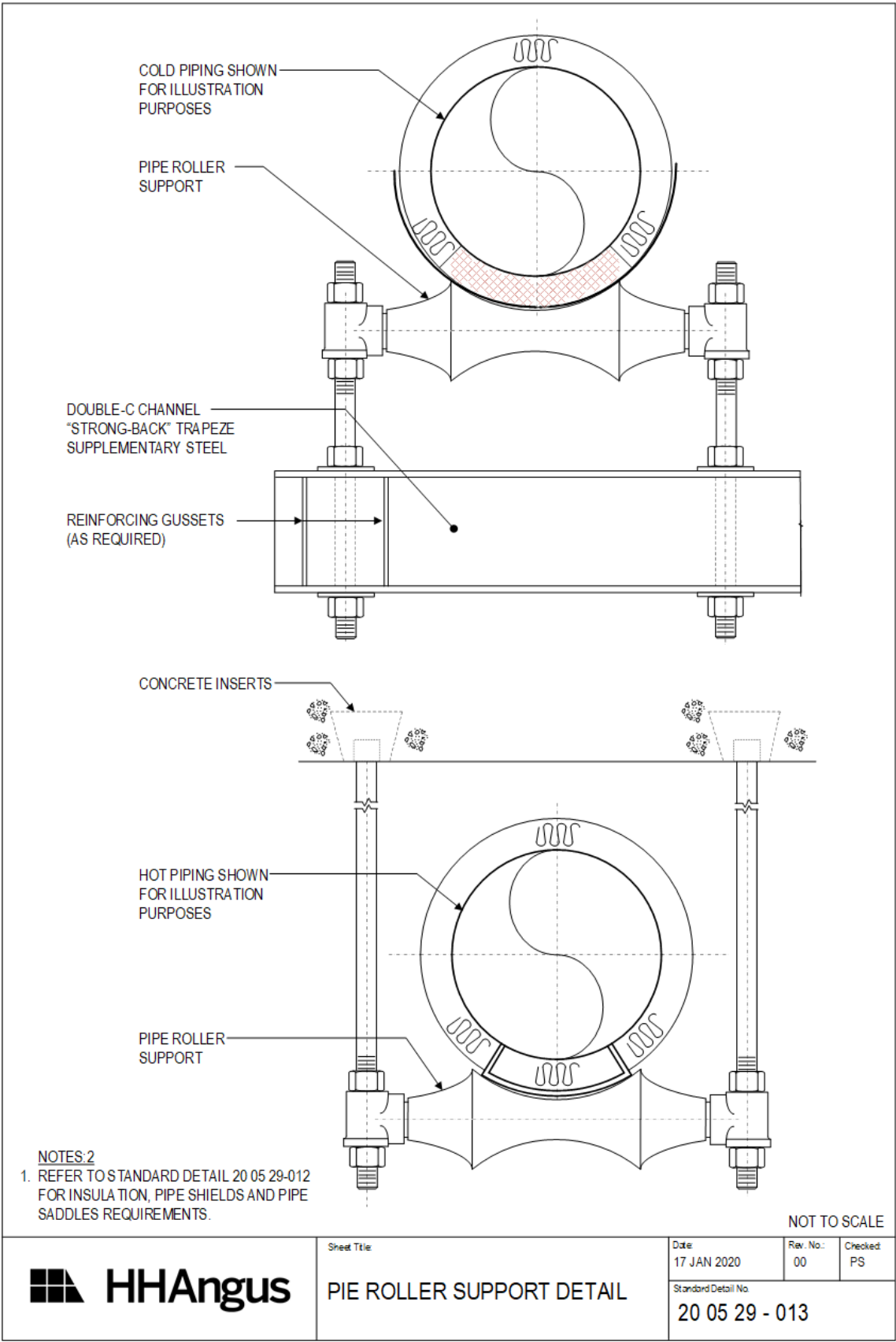
- .1 The following standard details are appended to the end of this specification section.
 - .1 20 05 29-010 Pipe Clevis Hanger – General Details
 - .2 20 05 29-011 Pipe Clevis Hanger – Hot and Cold Insulated Piping - Typical Details
 - .3 20 05 29-012 Yoke-Style Pipe Roll Hanger – Typical Details
 - .4 20 05 29-013 Pipe Roller Support – Typical Details
 - .5 20 05 29-014 Slide Base Supports – Typical Detail

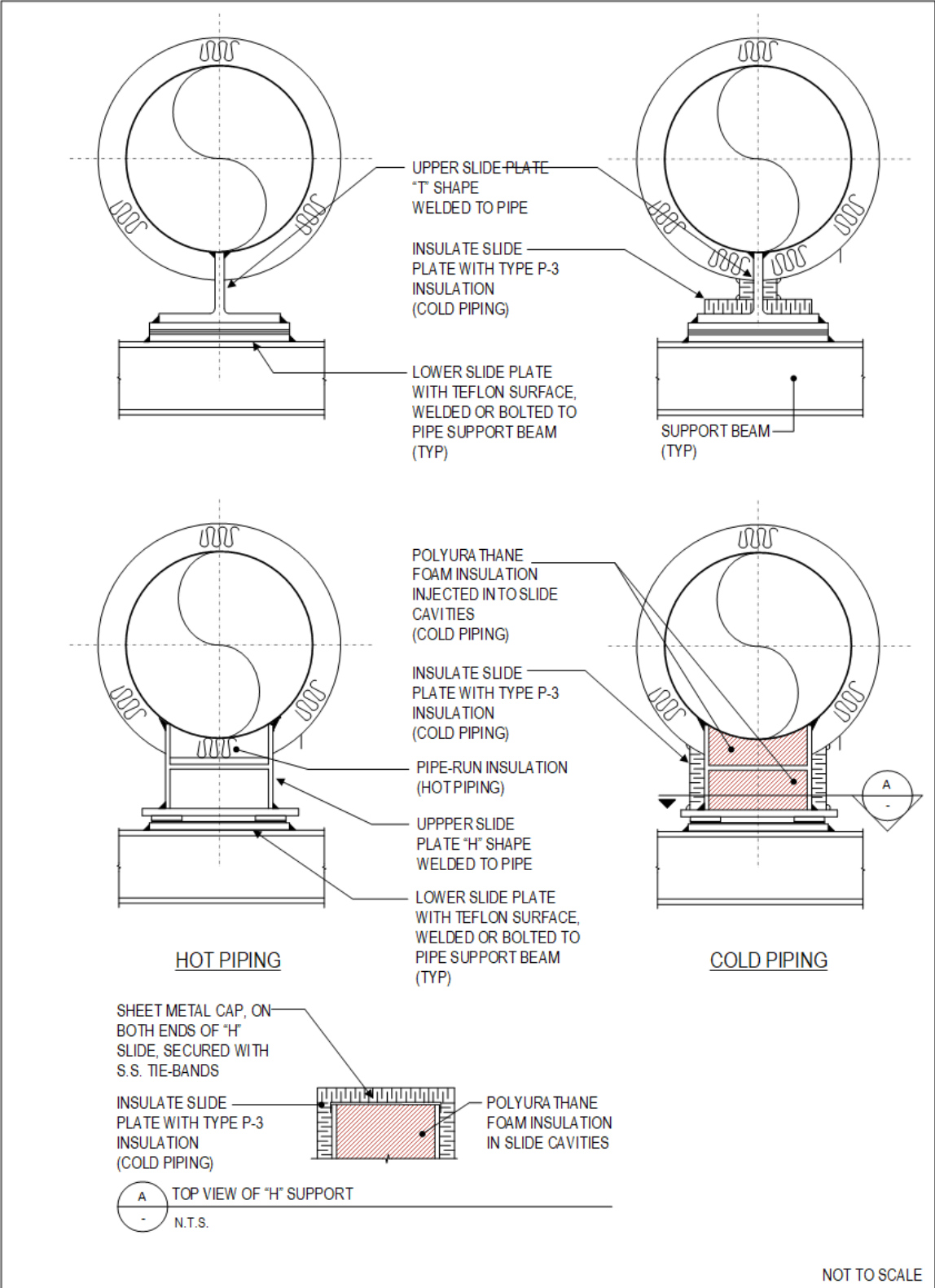
END OF SECTION











NOT TO SCALE



Sheet Title:
PIPE SLIDE BASE SUPPORT
DETAIL

Date: 28 MAY 2021	Rev. No.: 01	Checked: PS
Standard Detail No. 20 05 29 - 014		

Issued

VIBRATION ISOLATION

20 05 48

1 GENERAL

1.1 Scope

- .1 Provide vibration isolation equipment for;
 - .1 vibration control for motor-driven mechanical equipment,
 - .2 vibration control for piping and ductwork connected to motor drive equipment,
 - .3 movement control for piping due to thermal movement, and
 - .4 movement control for piping due to building movement.
- .2 Provide engineering services associated with the design, analysis and selection of vibration isolation supports, including pipe riser supports.
- .3 Refer to specification section 20 05 29 for installation requirements for variable and constant load supports for pipe riser in excess of 25 m (82 ft) in height.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 12 Wiring Requirements for Mechanical Services
 - .2 20 05 29 Common Hanger and Support Requirements for Piping
 - .3 20 05 49 Seismic Restraint
 - .4 20 05 16 Flexible Connections, Expansion Joints, Anchors & Guides
 - .5 23 33 05 Duct Accessories

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 ASTM A653-19 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .2 ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

1.4 Design Criteria

- .1 Isolator and base type designations are taken from the current ASHRAE Applications Handbook.
- .2 Base type, isolator type and minimum static deflection are shown in equipment schedules and/or equipment selection sheets.
- .3 Information shown in equipment schedules is to establish minimum standards and vibration isolation equipment to be selected to maintain noise levels in building below RC levels in following schedule.

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
-open plan	36 to 38

AREA	NOISE CRITERIA (NC level)
-business machine areas	40 to 42
-conference/boardrooms	30 to 32
Operating Rooms	25 to 27
Private Bedrooms	26 to 28
Hospital Wards	30 to 32
Public Areas	38 to 40

- .1 Provide a completely engineered design of pipe riser vibration isolated supports to minimize the pipe anchor loads under normal operating conditions, with engineering documents sealed by a professional engineer licensed in the jurisdiction of the Work.
- .2 Coordinate vibration isolation with seismic requirements under specification section 20 05 49.

1.5 Submittals

- .1 Submit shop drawings consisting of;
 - .1 product data sheets for isolation components,
 - .2 a schedule (or similar document) of vibration isolators selected for each piece of equipment, including equipment weight and isolator static deflection;
 - (a) where a common selection is used for multiple instances of the same equipment type, a single submission identifying all applicable equipment units is sufficient,
 - .3 drawing details for equipment bases, specific to each piece of equipment,
 - .4 fabrication details, location and size of anchor bolts and concrete requirements for inertia bases.
- .2 Submit shop drawings for the completely engineered pipe riser vibration isolation supports and pipe anchors;
 - .1 for each isolator, identify the estimated supported static loads, estimated supported operating loads (at temperature), spring deflections at static and operating conditions, spring deflections at static and operating condition, spring selections, and riser anchor design, including anchor loads at static and operating conditions,
 - .2 shop drawings to be sealed by a professional engineer licensed in the jurisdiction of the Work.

2 PRODUCTS

2.1 General Requirements

- .1 Provide vibration isolation equipment by one manufacturer.

Standard of Acceptance

- Vibro-Acoustics (Swegon NA)
- Kinetics
- BVA
- Korfund Mason
- Tecoustics

2.2 Resilient Isolator Pads – Type P1

- .1 Elastomer-in-shear pads:
 - .1 rubber waffle or ribbed pads:
 - (a) 45 or 60 durometer neoprene depending on loading, minimum of 22 mm (7/8 in) thick,
 - (b) load rating: up to 5 mm (0.19 in) static deflection and up to nominally 4400 kg (9700 lbs.) load,
 - .2 rubber-steel-rubber pads:
 - (a) two layers of rubber waffle or ribbed pad, 13 mm (½ in) thick, as specified above,
 - (b) bonded to 6 mm (¼ in) steel plate, with holes sleeved and fitted with isolation washers.
 - .3 Neoprene jacketed pre-compressed moulded fiberglass pads.

2.3 Elastomeric Mounts – Type M1

- .1 Molded neoprene mount:
 - .1 one piece, molded neoprene mount, with cast-in-top threaded steel load insert, and two hold down bolt openings on the bottom plate,
 - .2 load rating: up to 13 mm (0.5 in) static deflection and up to nominally 1800 kg (3960 lbs.) load,

2.4 Isolator Springs – Type S1

- .1 Open spring isolator:
 - .1 free-standing, open (un-enclosed) spring isolator, selected for static deflections as shown,
 - .2 upper load plate and leveling assembly, and bottom load plate with non-skid noise isolation pad and bolt holes for fastening to the floor,
 - .3 load rating: up to 50 mm (2 in) static deflection and up to nominally 8000 kg (17,600 lbs.) load,
 - .4 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
 - .5 overload capacity: 50% minimum,
 - .6 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

2.5 Isolator Springs – Type S2

- .1 Enclosed spring isolator:
 - .1 free-standing, enclosed (housed) spring isolator, selected for static deflections as shown,
 - .2 suitable for equipment subject to wind loads, large changes in mass due to change in water content, torque loads, and/or seismic loads,
 - .3 load rating: up to 100 mm (4 in) static deflection and up to nominally 8000 kg (17,600 lbs.) load,
 - .4 housing: fabricated and welded steel members, hot-dipped galvanized after fabrication, with;
 - (a) top load plate with adjusting and leveling bolts,
 - (b) vertical restraints with isolation washers,
 - (c) bottom plate with non-skid noise isolation pads and bolt holes for fastening to the floor,
 - .5 ratio of lateral spring stiffness to vertical spring stiffness:
 - (a) 1.2 or greater for equipment installed outdoors,
 - (b) 1.0 or greater for equipment installed indoors,

- .6 overload capacity: 50% minimum,
- .7 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

2.6 Isolation Springs - Type S3

- .1 Restrained open spring isolator:
 - .1 free-standing, open (un-enclosed) spring isolator, with vertical limit stops, selected for static deflections as shown,
 - .2 suitable for equipment subject to changes in mass due to change in water content,
 - .3 load rating: up to 50 mm (2 in) static deflection and nominally 1500 kg (3300 lbs.) load,
 - .4 spring assembly:
 - (a) top load plate with adjusting and leveling nut and bolt,
 - (b) integral vertical restraint limit with elastomeric washer,
 - (c) bottom fastening plate with noise isolation pad and mounting holes.
 - .5 ratio of lateral spring stiffness to vertical spring stiffness: 0.8 or greater.
 - .6 overload capacity: 50% minimum,
 - .7 springs coated in a colour-coded corrosion protection finish and tested with a 1000 hour salt spray rating to ASTM B117.

2.7 Isolator Springs – Type S4

- .1 Open spring thrust restraint isolators:
 - .1 horizontal arrangement, with equipment and structure mounting plates,
 - .2 open spring, with load plate and isolator bushing,
 - .3 static deflection to match equipment isolator.

2.8 Isolation Hangers – Type H1

- .1 Spring isolation hanger:
 - .1 open (un-enclosed) spring isolator for connection to upper and lower hanger rods, selected for static deflections as shown,
 - .2 a stamped or welded hanger bracket mount with elastomeric washer isolating the spring,
 - .3 bracket and spring: polyester powder coat finish,
 - .4 swivel arrangement to permit hanger box or rod to move through 30° of arc without metal to metal contact,
 - .5 load rating: 10 mm (0.4 in) to 50 mm (2 in) static deflection and up to nominally 1450 kg (3190 lbs.) load,
 - .6 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
 - .7 overload capacity: 50% minimum.,

2.9 Isolation Hangers – Type H2

- .1 Spring isolation hanger with elastomer-in-shear insert:
 - .1 Same as type H1 except as follows.

- .2 includes a neoprene elastomer-in-shear insert on the upper load connection, in series to the spring,
- .3 load rating: up to 100 mm (4 in) static deflection and up to nominally 1700 kg (3740 lbs.) load,

2.10 Isolation Hangers – Type H3

- .1 Neoprene isolation hanger:
 - .1 neoprene isolator for connection to upper and lower hanger rods,
 - .2 a stamped hanger bracket mount with isolator and load washer, with galvanized steel finish
 - .3 bracket and spring: polyester powder coat finish,
 - .4 swivel arrangement to permit hanger box or rod to move through 30° of arc without metal to metal contact,
 - .5 load rating: up to 15 mm (0.57 in) static deflection and up to nominally 900 kg (1980 lbs.) load,
 - .6 ratio of lateral spring stiffness to vertical spring stiffness: 1.0 or greater,
 - .7 overload capacity: 50% minimum.

2.11 Equipment Base – Type A

- .1 Vibration isolators attached directly to equipment,
- .2 No supplementary base required.

2.12 Equipment Base – Type B

- .1 Fabricated steel frame or rails (except cooling towers, evaporative fluid coolers, and evaporative condensers):
 - .1 prefabricated steel base for fans and other equipment requiring motor support,
 - .2 welded assemblies from structural sections,
 - .3 reinforced for motor and drive with;
 - (a) isolation elements attached to base brackets and
 - (b) adjustable motor slide rails.
 - .4 use height-saver isolator mounting brackets wherever possible,
 - .5 minimum vertical section of base selected on basis of motor size from following;

Motor Size Horsepower	Motor Size kW	Vertical Side mm (in)
up to 3	up to 2.2	75 (3)
7.5	5.5	100 (4)
20	15	150 (6)
50	37	200 (8)
over 50	37	250 (10)

2.13 Equipment Base – Type B-CT

- .1 Fabricated steel frame or rails – for cooling towers, evaporative fluid coolers, and evaporative condensers:
 - .1 prefabricated supplementary steel base for cooling towers, evaporative fluid coolers and evaporative condensers,
 - .2 fabricated from structural steel shapes, specifically designed for each equipment operating weight and support point locations,
 - .3 maximum beam deflection: not greater than 1/360 of span and not to exceed 12.5 mm (1/2 in),
 - .4 welded and/or bolted structural connections,
 - .5 hot-dipped galvanized grade Z700 (G235) to ASTM A653 after fabrication,

2.14 Equipment Base – Type C

- .1 Concrete filled inertia base:
 - .1 Type B base and as follows,
 - .2 full depth perimeter structural section or formed plate channel frame with;
 - (a) welded in place reinforcing rods running in both directions and
 - (b) 1 mm (20 ga) metal pans,
 - (c) base section filled with concrete, vibrated into place.
 - .3 spring mount units carried by height-saver gusseted brackets welded to frame and
 - .4 'T' shaped bases to support horizontal pump elbows.

2.15 Equipment Base - Type D

- .1 Roof curb isolation rails:
 - .1 manufactured with structural steel or aluminum upper and lower members, with continuous flexible reinforced water and air-tight seal fastened to upper and lower members,
 - .2 protected by removable metal weather shield,
 - .3 supported from lower members by stable steel springs,
 - .4 maximum static deflection: 50 mm (2 in),
 - .5 closed cell neoprene gaskets,
 - .6 constructed with neoprene cushioned restraints to resist wind load in any direction.

2.16 Acoustic Barriers for Anchors and Guides

- .1 Manufactured from 25 mm (1 in) thick neoprene isolation with ductile reinforcing material.

3 EXECUTION

3.1 General

- .1 Install vibration isolation equipment in accordance with manufacturer's instructions and locate isolation for equipment to provide stable support under saddles, frames and projections of equipment.
- .2 Select thrust restraints for equipment mounted on vibration isolation to limit movement during start-up and normal operation.

3.2 Equipment Bases

- .1 Provide equipment bases for equipment as shown on equipment schedule drawings.
- .2 Block and shim bases level at correct operating height. Set the bottom of bases to clear housekeeping pads under full static load conditions by:
 - .1 25 mm (1 in) minimum for type C bases, and
 - .2 50 mm (2 in) minimum for type A and B bases.

3.3 Equipment Vibration Isolation

- .1 Provide vibration isolators with required static deflection for motorized equipment as shown on equipment schedule drawings, except as otherwise specified herein.
- .2 Provide Type H1 isolators for in-line duct fans and fan-powered terminal boxes.
- .3 Provide Type H3 isolators for suspended unit heaters.
- .4 Provide Type S4 horizontal thrust restraints for horizontal discharge fans developing over 1.5 kPa (6 in wg) total static pressure, arranged symmetrically on either side of unit and attached at the center-line of thrust.
- .5 Provide vibration isolation rubber washers where isolator is bolted to floors, housekeeping pads or overhead structure.

3.4 Vibration Isolation for Service Connections to Vibration Isolated Equipment

- .1 Make ductwork connections to vibration isolated air handling equipment with flexible connections in accordance with specification section 23 33 05.
- .2 Make electrical connections to vibration isolated equipment with flexible liquid tight conduit in accordance with specification section 20 05 12.
- .3 Make pipe connections to vibration isolated equipment in accordance with specification section 20 05 16.

3.5 Vibration Isolation Piping Supports – General Requirements

- .1 Provide vibration isolators on pipe supports where piping is connected to motorized equipment that is supported on vibration isolators of any type, in accordance with the following table.

Location	Pipe Size NPS	Isolator Type	Static Deflection mm (in)
The first two pipe supports adjacent to the vibration isolated equipment	≥ 10	Variable support hanger to section 20 05 29	Equal to the equipment isolator static deflection, but not less than 20 (0.75)
	< 10	S1 or H2 [Note 1]	
The third pipe support adjacent to the vibration isolated equipment	All	S1 or H2	Equal to the equipment isolator static deflection, but not less than 20 (0.75)

Location	Pipe Size NPS	Isolator Type	Static Deflection mm (in)
The 4 th and 5 th support point from the vibration isolated equipment	≥ 6	S1 or H2	20 (0.75)
The 6 th support point from the vibration isolated equipment	≥ 10	S1 or H2	20 (0.75)
Within 15 m (50 ft) pipe-run distance of outdoor equipment	All	S1 or H2	20 (0.75)

Notes:

[1] Order springs pre-compress to suit the installed weight of the pipe filled with the operating fluid.

- .2 Provide acoustic barrier materials at pipe anchors and guides, located within pipe shafts, duct shafts, equipment and fan rooms, and up to the first anchor outside of these rooms or areas.

3.6 Thermal Expansion Supports for Pipe Risers

- .1 Unless otherwise shown for pipe riser supports to use variable or constant load pipe hangers in accordance with section 20 05 29, provide spring isolators for pipe supports to accommodate pipe thermal movement for vertical pipe (risers) as follows.
- .2 Where piping crosses building expansion joint, provide spring hangers at first two support locations of piping at either side of the construction joint line.

3.7 Start-up and Set-up

- .1 After installation of connections to resiliently mounted equipment;
 - .1 remove shims and blocking and adjust mountings to level equipment,
 - .2 adjust connections, hangers, snubbers, and restraints,
 - .3 ensure that there is no physical contact between isolated equipment and building structure.
- .2 On completion of installation and start-up of equipment;
 - .1 make arrangements for manufacturer/supplier of vibration isolation equipment to visit site, check the performance of the vibration isolation systems, inspect their installation, and submit written report,
 - .2 make corrections to installation in accordance with manufacturer/suppliers recommendations,
 - .3 provide notice 24 hours in advance of this site visit.

END OF SECTION

SEISMIC RESTRAINT FOR MECHANICAL SERVICES 20 05 49

1 GENERAL

1.1 Scope

- .1 Provide restraint devices to limit movement of piping, ducts, conduits, and equipment under seismic force and movement conditions and, where applicable, wind loads.
- .2 Provide engineering services for the design, selection of materials, installation instructions, and inspection of seismic restraint devices.
- .3 The requirements under this Specification section are in addition to the requirements for equipment, piping and duct supports and vibration isolation specified in other sections of Division 20.
- .4 Where specifications of materials of this section differ from those in other sections of Division 20, this section governs.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 16 Flex Connections, Expansion Joints, Anchors & Guides
 - .2 20 05 29 Common Hanger and Support Requirements
 - .3 20 05 48 Vibration Isolation
 - .4 26 05 49 Seismic Restraints for Electrical Services

1.3 Definitions

- .1 The following definitions apply for the purpose of this section.

Transverse restraint - restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

Longitudinal restraint - restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

Restraint: a device which limits movement of object due to imposed seismic forces acting on the object.

Brace: a restraint directly connected to an object that reacts against both tension and compression seismic loads.

Cable restraint: a restraint consisting of cables that reacts against only tension seismic forces, and that may have a small amount of slack to prevent vibration isolation short-circuiting during normal operation.

Snubber (restraint): a restraint that does not come into contact with the object under normal operating conditions.

- .2 The following abbreviations apply to this section:

"C_p" the horizontal seismic force coefficient as defined in NFPA 13.

“ K_s ” horizontal seismic force coefficient (equal to $0.3 F_a S_a(0.2) I_e S_p$, as defined in the National Building Code of Canada.

“ K_v ” vertical seismic force coefficient.

“ W_p ” the weight of the component subject to a seismic force.

.3 Interpretation:

- .1 In this specification, the parameter “ S_s ” (spectral response acceleration at 5 Hz) in NFPA 13, ASHRAE, SMACNA and MSS SP-127 used for estimating the horizontal seismic force, has the same meaning as the parameter “ $S_a(0.2)$ ” for the spectral response acceleration value at 0.2 seconds as defined in the National Building Code of Canada.

1.4 Applicable Codes and Standards

.1 Installation standards and codes:

- | | | |
|----|----------------|--|
| .1 | ASHRAE D-90316 | Practical Guide to Seismic Restraint |
| .2 | ANSI/SMACNA | Seismic Restraint Manual Guidelines for Mechanical Systems, 3 rd edition. |
| .3 | MSS SP-127 | Bracing for Piping Systems: Seismic - Wind - Dynamic Design, Selection, |
| .4 | NFPA 13 | Installation of Sprinkler Systems |

.2 Product standards:

- | | | |
|-----|---------------|--|
| .1 | ACI 355.2 | Qualification of Post-Installed Mechanical Anchors in Concrete |
| .2 | ASHRAE 171 | Method of Testing Seismic Restraint Devices for HVAC&R Equipment |
| .3 | ASTM A492 | Standard Specification for Stainless Steel Rope Wire |
| .4 | ASTM A1023 | Standard Specification for Stranded Carbon Steel Wire Ropes for General Purpose |
| .5 | ICC-ES AC01 | Expansion Anchors in Masonry Elements |
| .6 | ICC-ES AC106 | Predrilled Fasteners (Screws) in Masonry |
| .7 | ICC- ES AC156 | Acceptance Criteria for Seismic Certification by Shake-Table Testing of Non-structural Components |
| .8 | ICC-ES AC193 | Mechanical Anchors in Concrete Elements |
| .9 | ICC-ES AC308 | Post-Installed Adhesive Anchors in Concrete Elements |
| .10 | MSS SP-58 | Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation |

.3 Other documents:

- | | | |
|----|--------|--|
| .1 | ASCE 7 | American Society of Civil Engineers, Minimum Design Loads and Associated Criteria for Buildings and Other Structures |
|----|--------|--|

1.5 Seismic Analysis, Design and Inspection Services

- .1 Provide the services of a professional engineer, licensed in the province or territory of the Work and who specializes in seismic restraint of building services and equipment (the “Seismic Engineer”), for the design of seismic restraints and to provide inspection services of the completed installation.
- .2 Seismic Engineer design services;
- .1 Provide the design of seismic restraint systems, including seismic restraint calculations for all connections of equipment to the structure.

- .2 Provide design drawings showing locations of restraints and details of construction and attachment of restrains. Mark-ups of Consultant drawing or Contractor installation drawings may be used for this purpose.
- .3 Analysis of dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis to detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the seismic forces acting on the equipment or components and their support and restraint attachments to the building structure.
- .3 Seismic Engineer inspection services;
 - .1 At periods during installation and at completion of the installation of the seismic restraint devices, the Seismic Engineer shall inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected.
 - .2 Seismic Engineer to submit periodic inspection reports and a final inspection report after all work is completed and deficiencies have been corrected, confirming the installation conforms to the seismic design requirements. Prepare and submit any required declarations or similar document to this effect where required by local legislation.
- .4 Shop drawings of custom restraints, required calculations, and reports shall be sealed by the specialist seismic professional engineer.
- .5 Prepare and submit reports of inspections of the installation and a final general review report of the completed seismic installation.

1.6 Manufacturer's Services – Seismic Restraints

- .1 Manufacturer of seismic control equipment are responsible for:
 - .1 determining seismic restraint sizes and locations,
 - .2 provide calculations and supply materials for restraint of vibration isolated and non-isolated equipment,
 - .3 provide installation instructions, drawings and trained field supervision to ensure proper installation and performance including welding details,
 - .4 field inspection of manufactured support systems including roof curbs and other rooftop equipment supports at time of installation.
- .2 Seismic restraint products shall either be:
 - .1 approved by a government agency and indicate maximum restraint ratings, or
 - .2 provided with test results verified by an independent testing laboratory which state the maximum restrain ratings.

1.7 Manufacturer Services – Pipe Risers

- .1 Notwithstanding the requirements of section 20 05 29, engineered design services for pipe riser supports are required for all pipe risers.
- .2 Manufacturer of pipe riser supports are responsible for:
 - .1 complete engineering design of pipe riser support system including design and selection of pipe riser anchors, riser guides and riser isolators,
 - .2 provide calculations and supply materials for support of pipe risers to accommodate dead loads, dynamic loads and static seismic loads.
 - .3 Provide installation instructions, drawings and trained field supervision to ensure proper installation and performance including welding details.

1.8 Design Criteria

- .1 Design seismic restraint systems to conform to the provincial or territorial building code as applicable for the place of the Work. Seismic calculation and restraint methods as described in ASHRAE D-90316, SMACNA seismic guideline and MSS SP-127 are acceptable as the baseline requirement.
- .2 Design of seismic restraints to be based on actual equipment data (dimensions, weight, center of gravity, etc.,) obtained from submittals or the manufacturers of the equipment.
- .3 Testing and calculations of seismic restraints shall include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
- .4 Site design parameters:

Item	Description	Abbrev.	Value
1	Soil Class	--	C
2	Building Category	---	Post Disaster
3	Building Importance Factor	I _E	1.5
4	Spectral response acceleration factor	S _a (0.2)	0.249
5	Peak Ground Acceleration factor	PGA	0.160
6	Interstorey displacement factor	---	0.01

- .5 Building seismic force coefficient data;
 - .1 seismic horizontal force coefficients “K_s” and seismic vertical uplift force coefficient “K_v” for building service are listed in Schedule A attached to the end of this Section.
 - .2 seismic force coefficient “C_p” for fire protection piping is listed in Schedule A attached to the end of this Section.
- .6 Seismic force calculation (except fire protection piping);
 - .1 the horizontal seismic force “V_p” applied to a component is:
$$V_p = K_s \times W_p,$$
 - .2 the vertical seismic force “V_{PV}” applied to a component is:
$$V_{pv} = K_v \times W_p$$
- .7 Seismic force calculation for fire protection piping, including automatic sprinklers constructed in accordance with NFPA 13 and fire standpipes constructed in accordance with NFPA 14;
 - .1 the horizontal seismic force applied to a component is
$$F_p = C_p \times W_p \times 1.15,$$
 - .2 the vertical seismic force applied to a component is:
$$F_v = 0.15 \times C_p \times W_p \times 1.15.$$
- .8 For suspended equipment, the building elevation height is measured to the level of the floor above the suspended equipment.

- .9 For vibration isolated equipment, where the clearance distance (air gap) between the equipment support frame and the restraint (e.g. snubber or integral limit stop) exceeds 6 mm (1/4 in.), the seismic horizontal force V_p is to be increased by 100%.
- .10 Where adhesive anchors for concrete are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the " R_p " equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained.

$$K_{s,adhesives} = K_s \times R_{p,applicable\ equipment}$$

- .11 Where concrete inserts are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the " R_p " equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained and divided by the value of 1.5.

$$K_{s,inserts} = K_s \times \frac{R_{p,applicable\ equipment}}{1.5}$$

1.9 Seismic Qualification of Equipment

- .1 Applies where other specifications of Division 20 to 25 require equipment to be seismically qualified.
- .2 Design unitary or package equipment to withstand the seismic force criteria as specified herein.
- .3 Design the equipment base frame to allow anchoring of the packaged equipment to the supporting structure by use of through-bolt anchors.
- .4 Seismically qualify and certify complete unitary or packaged equipment by the shaker table method in accordance with ICC ES-AC156 and ASCE 7 for validating continued operation after the test seismic movement.
- .5 For clarity, calculation of seismic forces for use with ASCE 7 are subject to the following for installations in Canada:
 - .1 calculate seismic forces in accordance with the building code at the place of the Work, or in its absence the National Building Code of Canada,
 - .2 under ASCE 7, the " S_{DS} " parameter is equivalent to NBCC value equal to " $2/3 \cdot F_a(0.2) \cdot S_a(0.2)$ "
 - .3 under ASCE 7, the Component importance factor is to be read as the Building Importance Factor in accordance with the National Building Code of Canada,
 - .4 unless otherwise specified in the product technical Specification section, the building height factor under ASCE 7 of " z/h " is the same as NBCC " h_x/h_n " and is to have a value of 1.0.
 - .5 other factors in conformance with this Specification section.

1.10 Submittals

- .1 Submit shop drawings in accordance with Division 1 and as follows.
- .2 Seismic restraints:
 - .1 Provide test certificates for each seismic restraint device, identifying maximum tested load capacities.
 - .2 Provide calculations for each piece of restrained equipment, lengths of braced piping, ductwork and conduit, including seismic forces, restraint selection, and selection data.
 - .3 Provide a calculation analysis summary (spreadsheet is acceptable) for each piece of equipment, including the following information:
 - (a) Equipment ID,

- (b) Floor level,
 - (c) Horizontal seismic force factor,
 - (d) Equipment weight,
 - (e) Horizontal seismic force,-
 - (f) Vertical uplift seismic force (where applicable),
 - (g) Design condition (worst case) overturning moment,
 - (h) Number of restraint fastenings,
 - (i) Pull-out tension for worst case restraint,
 - (j) Compression for worst case restraint (vibration isolated equipment),
 - (k) Horizontal shear per fastener,
 - (l) Worst case simultaneous tension and shear loads at each restraint and snubber,
 - (m) Pull-out tension load rating per fastener,
 - (n) Horizontal shear rating per fastener.
- .4 Provide drawings for each type of restraint assembly, including details for connections to building structure, and associated bill of materials, and (where applicable) full welding details of field welds to structural elements.
 - .5 For building connections in concrete, provide concrete anchor sizes and nominal and effective embedment depth.
 - .6 Provide floorplan layout drawings indicating location of each restraint, identifying each restraint type in a manner to identify the restraint detail.
 - .7 Provide layout and construction details for reinforced housekeeping pads based on actual equipment to be restrained and selected concrete anchors. Shop drawings to include:
 - (a) minimum housekeeping pad plan dimensions and height, including reinforcement,
 - (b) details for securing the housekeeping pad to the structural floor slab,
 - (c) dimensioned position of restraint devices or combination isolator/restraint devices,
 - (d) minimum distance from concrete anchors to edge of housekeeping pad.
 - .8 Calculations and designs shall be sealed by a Professional Engineer licensed in the province or territory of the location of the project.
- .3 Pipe riser support system:
 - .1 Provide engineered layout drawings of pipe supports including anchors, guides and isolators, with supporting load calculation including dead loads, dynamic loads and static seismic loads, and reaction loads at building connection.
 - .2 Include:
 - (a) riser drawing indicating location of each support element for each for each piping system,
 - (b) installation instructions for presetting of pipe guides and isolators,
 - (c) riser clamp products or fabrication details of pipe brackets,
 - (d) riser clamping details as applicable for each riser pipe material.

1.11 Quality Assurance

- .1 Without limiting Contractors responsibility for quality assurance of the Work, the following minimum quality control processes are required.
- .2 Pre-Construction meeting;

- .1 Request and arrange a meeting with the Seismic Engineer and Consultant to review seismic restraint approach, prior to any restraint installation. Obtain approval from the Consultant before commencing work.
- .3 Initial installation and review;
 - .1 Install the first three transverse and three longitudinal braces for each fire protection systems, one (1) building service piping system, and one (1) ductwork system.
 - .2 Request and arrange for a review of the installation by the Seismic Engineer and Consultant. Obtain approval of the installation before commencing remainder of the work.
- .4 Provide services of the manufacturer's technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the Work. Provide a copy of the final inspection report to the Consultant for review. For clarity, these inspections are separate from those performed by the Seismic Engineer.
- .5 Provide services by the Seismic Engineer to conduct periodic reviews of the work in progress, and final review of the completed seismic restraint installation, before any ceilings are installed or work is otherwise concealed.
- .6 All deficiencies identified by the Seismic Engineer, manufacturer, or Consultant are to be rectified before equipment or services are concealed.

2 PRODUCTS

2.1 General

- .1 Seismic restraint materials to be provided by manufacturers specializing in the field of seismic restraint.

Standard of Acceptance

- Vibro-Acoustics (Swegon North America)
 - Kinetics Noise Control Inc.
 - B.V.A. Systems
 - Korfund (VMC)
 - Tecoustics
 - Hilti
 - nVent
- .2 Manufactured seismic restraints, anchors and related materials to be tested in accordance with ICC ES AC156 for loads meeting or exceeding the applied seismic forces of the Work.
 - .3 Seismic restraints for equipment supported by vibration isolators to be either:
 - .1 vibration isolators as specified in section 20 05 48 and provided with separate seismic snubbers, or
 - .2 combination vibration isolators with integral seismic snubbers.
 - .4 The following product articles describe the more common type of restraint devices. Other restraint devices are permissible provided they are qualified by 3rd party testing laboratories for seismic force restraint.

2.2 Seismic Snubbers

- .1 Type "SS1" – Single-Axis/Single Direction Snubbers:
 - .1 ASHRAE Type "I", designed to restrict movement in one axis,

- .2 carbon steel construction with epoxy or electrostatic paint finish, attached to floor or housekeeping pad with minimum of two bolts, faced with minimum 6.4 mm (1/4 in.) thick neoprene pad of compounded to bridge bearing quality,
- .2 Type "SS2 / SS3" – Multi-Axis/Multi-Direction Snubber Assemblies:
 - .1 ASHRAE Type "G" and "F", designed to restrict movement in two (2) lateral ("SS2") or three (3) axis ("SS3"),
 - .2 interlocking steel construction, attached to equipment structure and equipment, maximum of 6 mm (1/4 in) seismic movement,
 - .3 minimum 6 mm (1/4 in) thick resilient neoprene pads compounded to bridge bearing specifications, to prevent metal-to-metal impact,
 - .4 minimum two bolt attachments to the floor,

2.3 Seismic Restraint Brackets

- .1 Type "SRB" – Rigid Equipment Restraint Brackets:
 - .1 suitable for connection to equipment bases and tank bases,
 - .2 carbon steel "L" sections with epoxy or electrostatic paint finish, for fastening to both the floor structure/housekeeping pad and the equipment base,
 - .3 structure bolt opening equipped with neoprene bushing, compounded to bridge bearing quality,
 - .4 minimum two bolt fastening to equipment base using screws,
 - .5 suitable for equipment direct contact to floor with or without isolation pads,

2.4 Seismic Vibration Isolators

- .1 Type "2-S" – All Direction Neoprene Isolator:
 - .1 ASHRAE Type "E", designed to restrict movement in all directions with no metal-to-metal contact.
 - .2 molded, oil resistant neoprene compounded to bridge bearing quality, with encapsulated cast-in-place top steel load plate, and steel base plate with anchor holes,
- .2 Type "3-S" – Restrained Spring Isolator – Constant Load:
 - .1 ASHRAE Type "B", designed to restrict movement in all directions,
 - .2 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (1/4 in.) neoprene pad,
 - .3 removable coil spring element without having to disturb supported equipment,
 - .4 lateral stiffness greater than 1.2 times rated vertical stiffness,
 - .5 minimum 50% overload capacity,
 - .6 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
 - .7 steel housing design to limit lateral and vertical movement of the supported equipment,
 - .8 neoprene snubber, to limit maximum equipment movement in any direction to 6 mm (1/4 in.),
 - .9 location of snubbers designed to minimize prying action on floor bolts,
 - .10 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.
- .3 Type "4-S" – Restrained Spring Isolator – Variable Load:

- .1 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (¼ in) neoprene pad mounted under spring(s),
- .2 removable coil spring element without having to disturb supported equipment,
- .3 lateral stiffness greater than 1.2 times rated vertical stiffness,
- .4 minimum 50% overload capacity,
- .5 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
- .6 steel housing design to limit lateral and vertical movement of the supported equipment,
- .7 top load plate with adjustable and leveling bolts,
- .8 adjustable vertical restraints to allow unloading of water-bearing equipment,
- .9 isolation washers,
- .10 bottom load plate with anchor holes,
- .11 hot dipped galvanized for outdoor installations,
- .12 neoprene snubber compounded to bridge veering quality, to limit maximum equipment movement in any direction to 6 mm (¼ in),
- .13 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

2.5 Restraints and Braces for Distribution Services

.1 Type "SCR" – Cable Restraints:

- .1 manufactured system consisting of cable, building attachment, and vertical hanger rod reinforcement assembly,
- .2 field-built assemblies are not acceptable,
- .3 steel wire strand cables:
 - (a) galvanized steel aircraft cable to ASTM A1023, or stainless steel to ASTM A492
 - (b) sized for seismic load with a safety factor of 2,
 - (c) arranged for restraint in both longitudinal and transverse directions under tension loads only,
 - (d) connector strength rating equal to 90% of cable breaking strength rating.
- .4 building and equipment attachment brackets:
 - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
 - (b) protective loop thimbles at contact with connectors,
 - (c) rope connections: overlap wire "U" clips with at least two (2) bolt fasteners, or, tool-less wedge insert lock connectors,
 - (d) selected to exceed the cable working design load by 50%,
 - (e) single sided "C" beam clamps are not acceptable.
 - (f) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.

.2 Type "SSB" – Solid Braces:

- .1 factory-built or field assembled solid braces, consisting of structural-shapes, building attachment, and vertical hanger rod reinforcement assembly.
- .2 sized for seismic load with a safety factor of 2,

- .3 arranged for restraint in both longitudinal and transverse directions.
- .4 building and equipment attachment brackets:
 - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
 - (b) selected to exceed the working design load by 50%,
 - (c) single sided "C" beam clamps are not acceptable.
 - (d) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.
- .3 Vibration isolators for suspended pipes and ducts:
 - .1 applies where vibration isolators are specified for pipes or ducts in Specification section 20 05 48.
 - .2 type "H2" spring hanger in accordance with Specification section 20 05 48 and with two (2) travel-limit stops of neoprene washers with integral steel inserts which are located:
 - (a) on the top of the isolator housing, with an air gap of 6 mm (1/4 in.) between the neoprene washer and the structure connection point,
 - (b) on the underside of the isolator housing, supported by a nut on the hanger rod, and provided with an air gap of 6 mm (1/4 in.) between the underside of the isolator housing and the top of the neoprene washer.
- .4 Bracing of vertical hanger rods for SCR restraints and SRB braces:
 - .1 hanger rods braced to avoid potential for buckling;
 - (a) structural steel angle or formed channel brace selected to prevent support rod buckling,
 - (b) brace attached to support rod with a series of adjustable clips, without the use of hand-tools.
 - .2 hanger rods are not required where two SRB braces are provided at each seismic restraint location, and are installed at 180° opposition to each other.

2.6 Seismic Pipe Riser Support System for Piping Subject to Thermal Expansion

- .1 Application: for piping subject to thermal expansion including HVAC water systems, steam, domestic hot and cold water.
 - .1 not applicable to: drainage and vent piping systems, compressed gas and vacuum systems.
- .2 Complete engineered riser support system by support manufacturer.
- .3 Pipe riser anchors:
 - .1 outboard-mounted all-direction pipe anchors, designed for load bearing of pipe by means of pipe riser clamps or pipe support brackets,
 - .2 carbon-steel interlocking plates with bridge bearing quality neoprene pads, and painted finish,
 - .3 top-side loading plate with threaded UNC tapped mounting hole, for attachment by bolting to pipe riser clamp or welded to pipe bracket,
 - .4 variants for mechanical anchoring to concrete floor or field-welding to structural steel framing,
 - .5 one pair of guides per guide location.

Standard of Acceptance

- ° Vibro-Acoustics - fig. PRA, PRA-S

- .4 Pipe riser guides:

- .1 outboard-mounted pipe guides, designed for load bearing of pipe by means of pipe riser clamps or pipe support brackets,
- .2 carbon-steel sliding guides with EPDM lateral bushings and bridge bearing quality neoprene end pads, and painted finish,
- .3 top-side loading plate with threaded UNC tapped mounting hole, for attachment by bolting to pipe riser clamp or welded to pipe bracket,
- .4 one pair of guides per guide location.

Standard of Acceptance

- Vibro-Acoustics - fig. PRG, PRG-S

.5 Pipe riser isolators:

- .1 open spring assembly, with neoprene base and equipment loading plate, and mounting bolt hole for attachment by bolting to pipe riser clamp or welded to pipe bracket.
- .2 springs selected for four times the riser expansion or contraction at the supported location, to not exceed a maximum 25% load change between installed and operating condition.

Standard of Acceptance

- Vibro-Acoustics - fig. FST series

.6 Pipe riser clamps:

.1 Carbon steel pipe:

- (a) NPS 1-1/2 and under – carbon steel riser clamps, ANSI/MSS SP-58 type 8.

Standard of Acceptance

- Anvil - fig. 261

- (b) NPS 2 to 24 – 4 or 6 bolt carbon steel riser clamps, ANSI/MSS SP-58 type 42.

Standard of Acceptance

- Anvil - fig. 40

.2 Stainless steel pipe:

- (a) NPS ½ to NPS 12 – T304 stainless steel, ANSI/MSS SP-58 type 8.

- (b) special pattern with extended ears and 4 bolts to allow bearing on pipe riser anchors, guides and isolators.

Standard of Acceptance

- Anvil - fig. 261SS special.

.3 Copper tube:

- (a) NPS ½ to NPS 4 – carbon steel with copper plated finish, ANSI/MSS SP-58 type 8.

- (b) special pattern with extended ears and 4 bolts to allow bearing on pipe riser anchors, guides and isolators.

Standard of Acceptance

- Anvil - fig. CT-121 special.

.7 Pipe brackets:

- .1 purpose engineered, carbon steel structural shapes with reinforcing gussets, for full welding attachment to pipe and to load plates on pipe anchors, guides or isolators.
- .2 painted finish.

2.7 Seismic Pipe Riser Supports – Piping not Subject to Thermal Expansion

- .1 Use pipe riser clamps and guides in accordance with Specification section 20 05 29, except select components to have a load capacity equal to at least two times the combined dead weight, dynamic load and seismic load.

°

2.8 Mechanical Anchors

.1 General:

- .1 Post-installed mechanical anchors in concrete to be seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC193, and qualified by an ICC-ES seismic evaluation report.
- .2 Anchors installed in concrete masonry units to be seismically qualified in accordance with TMS 402/602 by testing for seismic tension and shear loads in accordance with ICC-ES AC01 or AC106, and be qualified by an ICC-ES seismic evaluation report.
- .3 Anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.

.2 Undercut anchors for post-concrete installation:

- .1 zinc-plated carbon steel bolt, nut, washer and cone-shape bearing-bell, with tungsten-tipped cutting radial edges, to create bearing force by keying into concrete,
 - (a) for outdoor use, all materials are to be stainless steel.
- .2 special undercut stop-drill bit and installation setting tool,
- .3 marking system to indicate when the anchor is completely installed,
- .4 designed for pre-setting of anchors and/or fastening of anchors through the equipment attachment opening,

Standard of Acceptance

- ° Hilti - fig. HDA (indoor), HDA-R (outdoor)

.3 Expansion wedge anchors for post-concrete or masonry unit installation:

- .1 zinc-plated carbon steel bolt, nut, washer, expanding segments and wedge mandrel, to create restraint force by friction and keying against/into adjacent concrete,
 - (a) for outdoor use, all materials are to be stainless steel.
- .2 torque- loading to determine complete installation,

Standard of Acceptance

- ° Hilti - fig. KB-TZ2 (concrete and masonry)
- ° Hilti - fig. HSL-3 (concrete only)

.4 Screw anchors for masonry units:

- .1 Zine-plated carbon steel masonry screw with hex washer head, to create restraint force by keying into concrete masonry units.
 - (a) for outdoor use, all materials to be stainless steel.

Standard of Acceptance

- Hilti - fig. KH-EZ series.

.5 Housekeeping pad anchors:

- .1 for installation prior to pouring of the housekeeping pad and post-installation of the structural floor,
- .2 tapered ductile iron body, with openings sized for two runs of Ø10mm (#3) reinforcing bar, and body NC threaded receiver for connection to undercut or expanding wedge anchors,
- .3 two pieces of Ø10mm (#3) reinforcing bar, of sufficient length to tie into housekeeping pad reinforcement,
- .4 undercut or expanding wedge anchor for connection to the structural floor slab.

Standard of Acceptance

- Mason Industries - fig. HPA

2.9 Adhesive Anchors

- .1 Adhesive anchors for post-concrete installation:
 - .1 seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC308.
 - .2 to have an ICC-ES seismic evaluation report, and be suitable for installation in cracked and uncracked normal- and light-weight concrete.
 - .3 anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
 - .4 injectable, two-component hybrid adhesive, matching threaded rod and accessories.

Standard of Acceptance

- Hilti - fig. HIT-HY 200

3 EXECUTION

3.1 General Requirements

- .1 Design and construct seismic restraints to;
 - .1 keep equipment and distribution services in place during and following seismic events,
 - .2 resist vertical loading simultaneously with transverse or longitudinal seismic loading.
- .2 Give special consideration to design for adjacent connections, insulation treatment, thermal movement, vibration isolation, and relation to building seismic joints.
- .3 Select restraint fastening systems so that full restraint will be provided assuming one failed fastener.
- .4 Install seismic restraint devices in accordance with manufacturer's instructions and Seismic Engineer's installation shop drawings.
- .5 Secure each transverse or longitudinal brace to the building structure, and not any other building service.

- .6 Restraint installation:
 - .1 install cable restraints with slack not exceeding a deflection of 12 mm (1/2 in.) measured at its midpoint, where equipment being restrained is supported on/by vibration isolators or for piping which is subject to thermal expansion,
 - .2 install cable restraints snug in all other applications,
 - .3 use solid braces only in rigidly supported situations,
 - .4 brace hanger rods forming a part of a seismic restraint to accept resulting compressive loads,
 - .5 install transverse and longitudinal braces at angles between 45 and 60° measured from the horizontal, unless the seismic bracing details by the Seismic Engineer states otherwise.
- .7 Concrete or masonry walls may be used as transverse duct restraints (but not pipe restraints), provide the wall is not a fire separation requiring the duct to be installed with a fire damper, and the annual space on any side of the duct does not exceed 12 mm (1/2 in.). Where the annual space exceeds this value, provide separate braces or use angle channels to secure the duct to the wall.
 - .1 drywall partitions, including demountable partitions, are not to be used for restraint.
- .8 Trapeze support and racks piping systems may have the rack braced (transverse and longitudinally) provided each pipe supported by the rack is restrained to the rack, while allowing thermal expansion as necessary.

3.2 Use of Pre-Engineered Bracing Details for Distribution Services

- .1 Use of pre-engineered restraint and bracing details in accordance with SMACNA (for ducts, piping and conduit) or MSS-SP-127 (for piping) is permitted. Where the installation of these services exceeds the limits of these documents, provide specific engineering restraint devices and systems.
 - .1 for SMACNA details, refer to the seismic hazard level ("SHL") by floor level in Schedule A of this Specification Section.
- .2 Fire protection automatic sprinkler systems and fire standpipe systems are to be braced in accordance with NFPA 13.
- .3 Provide cable restraints or bracing for transverse and longitudinal seismic restraints at spacing and locations as specified in the above referenced standards.
- .4 Exemptions for seismic restraints for distribution services (pipes, ducts, conduit) described in ASHRAE, SMACNA or MSS SP-127 are limited to the explicit exemptions described herein.

3.3 Exemptions for Duct Seismic Restraints

- .1 Except as described in paragraph .2 below, the following ductwork is not required to have seismic restraints where all the following conditions are met;
 - .1 ducts and duct supports are constructed to SMACNA duct construction standards,
 - .2 the extent of the free movement of the duct under seismic forces will not cause the duct to come into contact with other building services or building elements,
 - .3 HVAC ducts having a cross-sectional area of 0.56 m² (6 ft²) or less or have a linear weight for ducts and any insulation of 248 N/m (17 lb/ft) or less are exempt,
 - .4 HVAC or process ducts supported on trapeze assemblies with rod hangers, where the duct and any insulation have a linear weight of 146 N/m (10 lb/ft) or less are exempt,
 - .5 for other ducts not described in items.3 or .4 above are exempt where:

- (a) an individual duct is supported by hangers where the support height measured from the structural support to the top of the duct is 305 mm (12 in.) or less, and the hanger is attached to the duct within 50 mm (2 in.) of the top of the duct with a #10 sheetmetal screws, and
 - (b) rod hanger at the connection to the support structure are provided with a swivel in accordance with Specification section 20 05 29 to prevent bending of the hanger rod. Where such a device only provides rotation of the hanger rod in one plane, it shall be installed to allow transverse movement of the hanger rod.
- .2 Ducts conveying toxic or flammable gases, chemical or biological exhaust, or ducts used for smoke control or smoke venting are to be seismically restrained – no exemptions apply.

3.4 Exemptions for Pipe Seismic Restraints

- .1 Except as described in paragraph .2 below, the following piping is not required to have seismic restraints where all the following conditions are met;
- .1 the pipe is supported by hangers where the support height measured from the structural support to the top of the pipe is 305 mm (12 in.) or less,
 - .2 piping is supported on a trapeze where the support height measured from the structural support to the top surface of the trapeze is 305 mm (12 in.) or less,
 - .3 the rod hanger at the connection to the support structure is provided with a swivel in accordance with Specification section 20 05 29 to prevent bending of the hanger rod. Where such a device only provides rotation of the hanger rod in one plane, it shall be installed to allow transverse movement of the hanger rod, and
 - .4 the extent of the free movement of the piping under seismic forces will not cause the pipe to come into contact with other building services or building elements.
- .2 Piping conveying fuel oil, natural gas, propane gas and liquid, medical gases and compressed gases are to be seismically restrained – no exemptions apply.

3.5 Building Structural Connections

- .1 Select building connection devices based on seismic loads for actual equipment purchased.
- .2 For connection to concrete structures;
- .1 Anchors are to be selected for a load of not less than 1.3 times the horizontal seismic force “ V_p ”.
 - .2 Select building structure anchors as follows:
 - (a) post-installed undercut anchors or wedge-expansion anchors,
 - (b) concrete inserts may be used in new construction but only where complete seismic design is completed and seismic forces are adjusted to suit,
 - .3 Spacing between anchors: not less than 3 x the effective embedment of the greatest embedment length.
- .3 Where adhesive anchors or concrete inserts are used, the anchors are sized for an increased seismic force as described in article “Design Criteria”.
- .4 For connection to steel structures:
- .1 use double sided beam clamp, loaded to the centerline of the beam web, or
 - .2 were permitted by the building structural engineer, specifically designed welded or bolted connection may be used.
 - .3 the use of single sided “C” type beam clamps is not permitted for the connection to the building steel structure for hanger rods and seismic restraints.

3.6 Construction of Housekeeping Pads

- .1 Do not construct housekeeping pads until equipment restraint and anchors are designed and selected by the Seismic Engineer and/or seismic restraint manufacturer, and housekeeping pads detailed design are provided by the Seismic Engineer.
- .2 Provide housekeeping pads with integral reinforcement and structural anchors to the floor slab to withstand applied shear loads and anchor pull-out tension loads.
 - .1 provide reinforcing bar both directions on equal centers, and interior and perimeter floor anchors,
 - .2 in pre-installation construction, "Z-bar" shapes may only be used when housekeeping pad layouts are known prior to construction of the structural floor slab,
 - .3 in post-installations, use tapered housekeeping pad anchor assemblies,
 - .4 in post-installations, "L-rebar" shapes with adhesive anchors may be used, except the seismic forces in Schedule A of this Specification section must be increased as described above for adhesive anchors.
- .3 Pre-engineered details of construction for housekeeping pads as shown in chapter 6 of ASHRAE *Practical Guide to Seismic Restraint* may be used within its defined limits of application including but not limited to:
 - .1 housekeeping pad sizes are limited to 37 m² (400 ft²) or less,
 - .2 equipment center of gravity height does not exceed the width of the housekeeping pad,
 - .3 the ASHRAE maximum load rating includes the weight of the restrained equipment, vibration isolation equipment, support rails and bases, and the housekeeping pads,
 - .4 for values of "Fp" in ASHRAE, substitute the horizontal seismic force "Vp" as defined in the National Building Code of Canada for non-structural components (based on the seismic force coefficient "Ks" in Schedule A of this Specification section).
- .4 Size the housekeeping pad so that the distance from the equipment anchors to the edge of the pad is not less than 1.5 times the effective embedment depth of the equipment anchor, unless the anchor manufacturer requires greater separation distance.

3.7 Duct Restraints General Requirements

- .1 Use cable restraints or braces. Do not mix cable restraints and rigid bar restraints on the same duct system.
- .2 Use cable restraints for ductwork suspended on vibration isolators. Provide a small amount of slack in the cable to prevent vibration short-circuiting, with the slack not exceeding a lateral displacement of 12 mm (1/2 in.) at the center point of the cable.
- .3 Provide reinforcement of hanging rods to prevent buckling of the rod.

3.8 Piping Restraints General Requirements

- .1 Use cable restraints for piping subject to thermal expansion, including but not limited to chilled water, heating water, steam and glycol heating/cooling water.
- .2 Use cable restraints for piping supported on vibration isolation hangers or supports.
- .3 Use cable restraints or braces for all other piping.
- .4 Thermal expansion pipe anchors and guides on piping systems may be used as both a transverse and longitudinal seismic restraint where they are designed for concurrent thermal and seismic loadings.
- .5 Provide reinforcement of hanging rods to prevent buckling of the rod.

- .6 Where clevis hangers are used, provide a brace for the clevis cross bolt consisting of Schedule 40 pipe of the smallest size to fit over the clevis cross bolt, of a length to provide a 6 mm (1/4 in.) total gap between the reinforcement and the clevis frame.
- .7 For trapeze hangers, provide U-bolts over piping to limit lateral and vertical movement, but allow approximately 6 mm (1/4 in.) total clearance to allow pipe thermal expansion movement.
- .8 Attach restraints to pipe hangers and trapezes. For existing piping, restraints may be attached to the pipe using pipe clamp assemblies manufactured for this purpose.
- .9 Where pre-engineering restraints in accordance with SMACNA or MSS SP-127 are used, the spacing for transverse and longitudinal restraints are to be reduced to 50% of the stated spans in these documents for the following piping systems:
 - .1 steel piping with threaded joints,
 - .2 plastic piping including but not limited to PVC, CPVC, PP, and PVDF,
 - .3 fiberglass-reinforced pipe,
 - .4 cast iron drainage piping with no-hub connectors,
 - .5 glass drainage piping.

3.9 Piping Movement Control at Equipment Connections

- .1 Provide flexible connectors at piping connections to equipment in accordance with Specification section 20 05 16 except/and as follows.
 - .1 The following table for pump connectors takes precedence over the requirements of Specification section 20 05 16.

Service	Pump Type	Limits	Connector Type
Heating pumps Glycol Heating pumps Condensate pumps	Base Mount	Flange NPS 6 to NPS 14	Bellows
		Flange NPS 4 and smaller	Corrugated
	Vertical In-Line	All	Corrugated
	Circulator	All	Flexible Metal Hose
Steam Feedwater pumps	Base Mount or Multi-stage	NPS 3 and larger	Bellows
		NPS 2 ½ and smaller	Flexible Metal Hose
Chilled water pumps Glycol cooling pumps	Base Mount	Flange NPS 10 to NPS 14	Bellows
		Flange NPS 8 and smaller	Corrugated
	Vertical In-Line	All	Flexible Metal Hose, Double-arch flexible rubber
	Circulator	All	Flexible Metal Hose
Condenser water pumps	Base Mount	All	Corrugated, Double-arch flexible rubber

Service	Pump Type	Limits	Connector Type
	Vertical In-Line	All	Corrugated, Double-arch flexible rubber
Domestic Booster pumps	All	All	Corrugated
Sump pumps (sanitary and storm)	All	All	Flexible Metal Hose
Fire pumps	All	All	Flexible Metal Hose

- .1 The following table for equipment connectors takes precedence over the requirements of Specification section 20 05 16.

Equipment Type	Limits	Connector Type
Refrigeration Water Chillers	Chilled Water Piping	Corrugated connector, Double-arch flexible rubber
	Condenser Water Piping	Corrugated Connector, Double-arch Flexible Rubber
	Refrigerant Relief Piping	Corrugated Connector
Cooling Towers	Condenser Water Piping	Double-arch Flexible Rubber (indoors) Corrugated Connector (outdoors)
	Domestic Water Piping	Corrugated Connector
Refrigeration Condensing Units and Condenser Units	All	Flexible Metal Hose
Steam, heating and cooling coils, and humidifiers	All	Flexible Metal Hose, Corrugated Connector
Hot water reheat coils, Fan Coil units	All	Flexible Metal Hose, Flexible Non-Metallic Hose
Duct mounted humidifiers	All	Flexible Metal Hose, Flexible Non-Metallic Hose
Heat Exchangers	All	Flexible Metal Hose, Corrugated Connector
Domestic Hot Water Tanks	All	Flexible Metal Hose, Corrugated Connector
Medical Air Compressor, Medical Vacuum Pumps, Medical Gas cylinders	All	Flexible Metal Hose (bronze internals)
Air compressors, Compressed gas cylinders	All	Flexible Metal Hose

Equipment Type	Limits	Connector Type
Other equipment not specifically listed	NPS 2 and smaller	Flexible Metal Hose
	NPS 2-1/2 and larger	Corrugated Connector

- .2 Provide seismic restraints at ends of piping where connected to equipment, to limit pipe movement so that it does not cause the flexible connector devices at the equipment to exceed their lateral movement rating;
 - .1 For pipe drops to equipment, provide a pipe guide on the pipe immediately above the flexible connector device, with clearance of not more than the lateral deflection rating of the flexible connector. Line the pipe guide with 6 mm (1/4 in.) neoprene pads of bridge bearing equality. Support the guide from the floor level.
 - .2 this requirement applies to piping that is otherwise exempt from seismic restraints.

3.10 Piping Risers Restraints

- .1 Use pipe anchors and guides for seismic restraints of vertical pipe risers. Do not use separate cable restraints or braces.
- .2 For horizontal seismic forces acting on vertical pipe risers, use the seismic force coefficient “Ks” value at the floor location of the pipe anchor or guide (as applicable), and the restrained weight is to include 50% of the pipe and fluid content weight between the anchor or guide and the next anchor or guide, in both vertical directions.
- .3 For piping subject to thermal expansion:
 - .1 provide fully engineered pipe riser support system,
 - .2 for steel pipe;
 - (a) provide an anchor at the location shown,
 - (b) construct the anchor assembly using heavy-duty pipe riser clamps or pipe brackets with full-welded connections to the pipe, and full-welded or bolted connections to the anchor. Use mechanical anchors to bolt the pipe anchor to concrete floor, and weld pipe anchors to steel framing.
 - (c) unless otherwise shown, use a heavy-duty pipe riser clamp with a load capacity not less than two times the combined dead weight of pipe and water, dynamic load and seismic loads.
 - .3 for copper tube,
 - (a) attach a copper sleeve that matches the OD of the tube and fully braze the sleeve to the tube.
 - (b) alternatively, use a slip-on flange over the tube and fully-braze the flange to the tube,
 - (c) position the sleeve or flange immediately above and bearing on a pipe riser clamp, which is bolted to the riser anchor.
 - .4 based on engineered support design, provide intermediate isolator supports.
- .4 For piping not subject to thermal expansion;
 - .1 provide pipe guides and riser clamps for piping not subject to thermal expansion in accordance with Specification section 20 05 29,
- .5 For all piping;
 - .1 for cast iron DWV pipe, plastic DWV pipe, and glass DWV pipe, provide a guide at each floor level.

- .2 for all other piping, provide guide or riser clamp at every other floor but not to exceed 7.6 m (25 ft) spacing, unless engineering design determines other spacing dimensions,

3.11 Conduit Restraints

- .1 Conduits for mechanical wiring are to be restrained in accordance with the requirements of section 26 05 49.

3.12 Floor Mounted Equipment Restraints

- .1 Anchor floor mounted equipment with anchor bolts, minimum four bolts for rectangular equipment bases, and three bolts for circular equipment bases.
 - .1 friction due to gravity loads shall not be considered to provide resistance to seismic forces.
- .2 For non-isolated equipment, secure equipment directly using equipment base supports or use SRB brackets. Alternatively, use type SS1 or SS2 snubbers where equipment is not subject to overturning moments. Use type SS3 snubbers where equipment is subject to overturning moments;
 - .1 for type SS1 snubbers, provide a minimum of eight (8) snubbers for each piece of equipment, with two units placed on each corner of the equipment base frame.
 - .2 for type SS2 and SS3 snubbers, provide a minimum of four (4) snubbers for each piece of equipment, with one unit placed on each face of the equipment base frame.
- .3 For round equipment bases, such as expansion tanks with floor-support ring without mounting flanges, use type SS3 snubbers or purpose-constructed clamps to positively attach to the equipment base and anchored to the floor. Welding to the equipment base is permitted only where the equipment manufacturer information permits this method of attachment.
- .4 Provide resilient neoprene bushings and washers between equipment and anchor bolts where equipment is secured rigidly to floor or housekeeping pad.
- .5 Install snubber devices only after equipment is installed and operating, to ensure no metal-to-metal contact. Adjust snubbers so that any clearance gaps do not exceed 6 mm (1/4 in.).
- .6 For floor mounted equipment with vibration isolators;
 - .1 select basic vibration isolator in accordance with Section 20 05 48.
 - .2 select seismic restraint for each piece of equipment of either:
 - (a) integrated seismic vibration restraint type 2-S, 3-S or 4-S, or
 - (b) vibration isolator in accordance with Section 20 05 48 combined with seismic snubbers SS1, SS2 or SS3 as applicable to suit overturning moment.
 - .3 Do not mix type of restraint on the same piece of equipment.
 - .4 Where the equipment is not provided with a structural base to transfer seismic forces, provide a structural-shape or formed steel channel base or a Type C inertia base as a complete steel frames suitably cross braced in both horizontal directions to withstand seismic induced shear force and bending moments.

3.13 Suspended Equipment Restraints

- .1 For isolated equipment, select basic vibration isolator in accordance with Section 20 05 48.
- .2 Provide restraints for equipment independent of restraints provided on connecting ductwork or piping.
- .3 Provide reinforcement of hanger rods to prevent buckling.
- .4 Provide SCR type longitudinal and transverse restraints at each corner of the equipment (total of eight (8) cables). Alternatively, a single SCR cable can be installed at each corner of the equipment,

positioned at 45° to both transverse and longitudinal direction and sized for concurrent transverse and longitudinal loads.

3.14 Rooftop Fans

- .1 Fasten vibration isolators (where applicable) and seismic restraints to roof curbs or sleepers with mechanical fasteners of the type determined by the seismic restraint manufacturer.
- .2 Fasten roof curbs or sleepers to the roof structure with bolted angles positioned at each restraint. Fastening of curbs or sleepers to roof with roofing adhesive only is not acceptable.

3.15 Equipment Restraints - Surface Wall-Mounted Equipment and Panels

- .1 Application: for non-rotating mechanical equipment, electrical panels, control panels, motor controllers, and other electrical distribution equipment.
- .2 Attach equipment to horizontal galvanized steel channels and fasten with bolts equipped with neoprene isolation grommet washers. Channels to extend past the side of the equipment to allow anchoring to wall. Select bolts for concurrent shear dead-weight without deduction for uplift load, and tension restraint load.
- .3 Attach channels to concrete or masonry walls with not less than four (4) anchors with each anchor having a not less than a 1.5 safety factor.

3.16 Equipment Restraints - Recessed Wall-Mounted Equipment

- .1 Application: for non-rotating mechanical equipment, electrical panels, control panels, motor controllers, and other electrical distribution equipment.
- .2 Mount recessed equipment through the top, bottom and sides of the equipment housing to adjacent block wall or wall studs.

3.17 Inspection, Testing, Adjustment and Reporting

- .1 For equipment supported on vibration isolators, field measure air gaps on each restraint and if necessary adjust the restraint so that the clearance air gap does not exceed 6 mm (1/4 in.). Provide a written report identifying the results of each test and adjustment, to the Seismic Engineer and Consultant for review.
- .2 Arrange for the seismic restraint manufacturer to inspect and report on the installation at completion of the work. Make corrections of deficiencies identified by the manufacturer. This work is to be performed prior to the final field review by the Seismic Engineer.
- .3 Arrange for Seismic Engineer to conduct a final inspection prior to substantial performance of the Work. Make corrections of deficiencies identified by Seismic Engineer. This work is to be performed prior to the final field review by Consultant.
- .4 Make corrections of deficiencies identified by Consultant.
- .5 Submit the following reports prior to application for substantial performance of the Work, or where applicable, ready-for-takeover of the Work:
 - .1 Seismic Engineer periodic and final inspection reports,
 - .2 seismic restraint manufacturer inspection reports,
 - .3 Seismic Engineer declaration of general review.

END OF SECTION

IDENTIFICATION FOR MECHANICAL SERVICES

20 05 53

1 GENERAL

1.1 Scope

- .1 Provide identification nameplates, labeling for piping, ductwork, equipment, and valves, and specialty signage.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ANSI Z535.1 Standards for Safety Signs and Labels
 - .2 ASME A13.1 Scheme for the Identification of Piping Systems
 - .3 CSA Z7396.1 Medical Gas Pipeline Systems – Part 1: Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems

1.3 Submittals

- .1 Shop drawings:
 - .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 General

- .1 Manufactured identification systems:
 - .1 resistant to general chemical, and ultraviolet stabilized for outdoor use,
 - .2 minimum operating temperature: -25°C (-12°F),
 - .3 maximum operating temperature: 121°C (250°F).
 - .4 language: English

Standard of Acceptance

- Brady - identification tapes, bands, and markers.
- Seton - Setmark Pipe Markers.
- Smillie McAdams Summerlin.
- Craftmark Identification Systems.
- Primark

2.2 Engraved Equipment Identification Nameplates

- .1 Laminated nameplates:
 - .1 laminated two-layer coloured plastic plates, with engraved lettering,
 - .2 minimum size: 90 mm x 40 mm x 2.5 mm (3 in x 1½ in x ⅛ in),
 - .3 letter height:
 - (a) ID and name: 20 mm (¾ in.) minimum
 - (b) power source: 10 mm (⅜ in) minimum,

- .4 provided with Class 125 barcode and tag file,
- .5 nameplate colours:
 - (a) nameplate and letter colours are dependent on type of electrical power supply to equipment.

Power Source	Background Colour	Letter Colour
Normal or None	White	Black
Life-Safety/ Emergency	Red	White
Stand-by (non-life safety)	Orange	White
UPS	Blue	White

2.3 Piping Identification – Piping Systems other than Medical Gas Systems

- .1 General:
 - .1 conform to ASME A13.1 and as shown in Schedule A at the end of this Section for marking colours and global harmonization system (GHS) hazard identification symbols.
 - .2 text height:

Pipe/Tube NPS	Marker Length mm (in)	Text Height mm (in)
≤ 1-1/4	200 (8)	13 (0.5)
1.5 to 2	200 (8)	19 (0.75)
2.5 to 6	300 (12)	32 (1.25)
8 to 10	600 (24)	65 (2.5)
>10	800 (32)	90 (3.5)

- .2 Flexible coil-wrap manufactured markers:
 - .1 PVC plastic coated markers with integral printing, or plastic cover with field applied self-adhesive markers,
 - .2 reversing text with integral arrow markers,
 - .3 application method:
 - (a) NPS ½ to NPS 6: full wrap of pipe
 - (b) NPS 8 and over: partial pipe wrap with perforations for securing with nylon tie-wraps, tie-wraps included.
- .3 Self-adhesive polyester pipe name marking tape:
 - .1 reversing text with integral flow direction arrow markers,
 - .2 tape height: 65 mm (2.5 in) minimum.
- .4 Self-adhesive vinyl flow direction marking bands:
 - .1 colour band tape with flow direction arrows,
 - .2 colours: as specified for pipe name markers.
 - .3 tape width: 50 mm (2 in)

- .4 tape length: wrapped around pipe or covering with ends overlapping one pipe diameter but not less than 25mm (1 in).
- .5 flow arrow: 20 mm (¾ in) minimum high

2.4 Buried Piping

- .1 Stretchable polyethylene or metallized ribbon, labeled with name of service, with service name at maximum 800 mm intervals.

2.5 Ductwork Identification

- .1 Punched stencils in PVC or card material, suitable for application of field painting.
- .2 Letter height: 50 mm (2 in).
- .3 Letter paint colour: black.

2.6 Valve and Steam Trap Identification

- .1 Engraved plastic laminate tags:
 - .1 text for valves:
 - (a) piping system fluid service, area location description, following by a series number
 - (b) where a valve is shown on drawings to be normally closed, include "Normally Closed"
 - .2 text for steam traps: abbreviation for steam pressure (e.g. "S70") as shown, followed by a series number,
 - .3 tag background colour and test colour: same as for pipe markers in accordance with Schedule A at the end of this section.
 - .4 brass or stainless steel chain.

2.7 Miscellaneous Identification

- .1 Self-adhesive polyester marking labels with global harmonized system (GHS) hazard pictograms.
 - .1 red border on white field,
 - .2 symbol height: 100 mm (4 in) minimum.

2.8 Signage

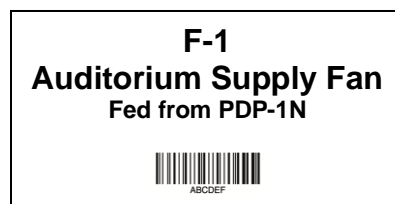
- .1 Rigid plastic signs, UV stabilized and suitable for indoor and outdoor installation, for surface mounting.
- .2 Graphic symbols:
 - .1 graphic image in accordance with WHIMS and ISO 7010,
 - .2 sign dimensions:
 - (a) indoors: 300 x 300 mm (12 in. x 12 in.)
 - (b) outdoors: 450 x 450 mm (18 in. x 18 in.)
- .3 Colours:
 - .1 Field and text colours in accordance with ANSI Z535.1

Information Type	Background Colour	Letter Colour	Primary Notification Text
General information	Blue	White	NOTICE
General Safety, Exiting	Green	White	---
Caution	Yellow	Black	CAUTION
Warning	Orange	Black	WARNING
Danger	Red	White	DANGER
Biological	Fluorescent Orange	Black	BIOHAZARD

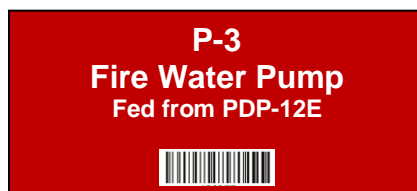
3 EXECUTION

3.1 Equipment Identification

- .1 Where required:
 - .1 provided for equipment identified with number designations shown in equipment schedules, drawings, specifications, and/or equipment selection sheets.
 - .2 marked with equipment ID, service name, and power source using wording and numbering used in contract documents.
 - .3 for clarity, equipment identification nameplates are in addition to manufacturers plates.
- .2 Locate nameplates to be easily read, and fasten securely with mechanical fasteners. For pressure vessels, secure nameplates to equipment with high-tensile epoxy adhesive.
- .3 Do not paint over equipment manufacturer or field installed nameplates.
- .4 Provide metal standoffs on insulated equipment.
- .5 Examples:
 - .1 at equipment (fan, pump, etc.), illustrated for Normal Power:



- .2 at motor starter, adjustable frequency drive, and separate local disconnect, illustrated for Emergency Power:



3.2 Piping Identification - Except Non-Medical Gas Systems

- .1 Provide manufactured pipe markers of the following types based on area of the building:
 - .1 self-adhesive type:
 - (a) indoor uninsulated piping,
 - (b) indoor insulated piping with PVC or smooth metal jackets,
 - .2 flexible coil-wrap:
 - (a) outdoor piping,
 - (b) indoor insulated piping with any type of jacket.
 - .3 Install self-adhesive markers on cleaned and prepared surfaces free of dirt and oil.
- .2 Install pipe markers in the following locations:
 - .1 maximum every 15 m (50 ft) along length of pipe, except for natural gas and fuel oil,
 - .2 maximum every 6 m (20 ft) along length of pipe for natural gas and fuel oil,
 - .3 within 1 m (3 ft) of each side of barriers, floors and walls,
 - .4 within 1 m (3 ft) of and behind access doors ,
 - .5 within 1 m (3 ft) of piping termination point.
- .3 Marker colours and hazard identification:
 - .1 Use the existing piping marker colour coding system for building additions and alterations.

3.3 Ductwork identification

- .1 Paint stenciled letters showing;
 - .1 duct service,
 - .2 fan number, and
 - .3 arrows showing direction of flow,
- .2 Paint stencil markings at the following locations:
 - .1 exposed ducts at 15 m (50 ft) intervals in service rooms,
 - .2 exposed ducts at wall and floor penetrations in other than service rooms,
 - .3 concealed ducts above drywall-ceilings next to access doors, and
 - .4 concealed ducts above removable tile ceilings at wall and floor penetrations, and at 15 m (50 ft) intervals.
- .3 Stencil indication on prepared surfaces, and locate on both sides of any penetration.

3.4 Valve Identification

- .1 Provide valves with a numbered tag showing valve type and size, attached to valve stem or wheel handle with chain.

- .1 Valve identification is not required at the following valves:
 - (a) inside fire hose cabinets,
 - (b) radiation heating units, unit heaters, or fixture stops,
 - (c) plumbing fixture service stops,
 - (d) within 4 m (12 ft) and in sight of equipment, fixtures, or apparatus that the valve controls provided there is no branch piping between the valve and equipment served,
 - (e) existing valves that are not provided under this project.
- .2 Identification information – manual valves:
 - .1 each valve tag to indicate fluid service, sequential valve number (unique for each service) including supply or return, location identifier, and normal operating position
 - .2 examples (colour coding shown for illustration):

Domestic Cold Water
Riser C/1
No. 12

Natural Gas
Boiler Plant
No. 2
Normally Closed

- .3 Identification information – automatic control valves:
 - .1 provide valve tags for all automatic control valves except as follows:
 - (a) within sight of equipment that the valve controls.
 - .2 each valve tag to indicate fluid service, control function, control valve identification number,
 - .3 examples (colour coding shown for illustration):

Chilled Water
Constant Pressure
Differential Valve
CV-3

- .4 Provide a tag schedule for each system, designating valve numbers, fluid service, function, valve size, and location of each tagged item and normal operating position of each valve. Submit copies in original file format (Excel, Word) on two (2) removable mass storage devices.

END OF SECTION

MECHANICAL SERVICES FOR GENERAL FACILITY EQUIPMENT

20 05 73.13

1 GENERAL

1.1 Scope

- .1 Provision of mechanical services for general facility equipment not supplied by Divisions 20 to 25 including services for
 - .1 general equipment,
 - .2 sterilizer equipment,
 - .3 laundry equipment,
 - .4 kitchens cooking equipment,
 - .5 water-cooled refrigerators and freezers,
 - .6 laboratory benchwork.
- .2 Mechanical services for specialized equipment is found in other sections of Division 20.

1.2 Related Sections

- .1 Where the requirements of this section conflict with the requirements of a related section, the requirements of this section 20 05 73.13 govern.

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Equipment** – means appliances, components, sub-assemblies, devices, apparatus or any collection thereof.
 - .2 **Gas** – means fuel gas (natural gas or propane) unless proceeded with a specifically named compressed gas (e.g. compressed air, nitrogen, etc).ds
 - .3 **Interconnecting services** – means mechanical services such as piping, ducting, or control wiring, between two or more components or sub-assemblies of a designated equipment.
 - .4 **Mechanical services** – means fire protection, plumbing and drainage, HVAC, building automation, and associated services, singly and in any combination thereof.
 - .5 **Supplied by Other Trades equipment (SOT)** – means equipment which is provided and set in place under a Division of the Work other than Divisions 20 to 25.
 - .6 **Supplied By Owner equipment (SBO)** – means equipment or any other thing that is purchased directly by the Owner and supplied free-issue to the general contractor for installation, and includes relocation and reinstallation of existing Owners equipment.
- .2 Any reference to a “general contractor” herein applies equally to a construction manager as applicable to the contract arrangements with the Owner.

1.4 Registration and Inspection

- .1 Where SBO or SOT equipment is subject to inspection, registration or approvals by any applicable AHJ, the responsibility for obtaining any required inspectors, registration or approvals of the equipment is by the person supplying the SBO or SOT equipment.

- .2 Where SBO or SOT equipment is subject to such inspection, registration or approvals, mechanical services may be connected to the equipment but not energized until such AHJ approvals are in place for the SBO or SOT equipment.
- .3 For clarity, where mechanical services to the SBO or SOT are subject to inspection, registration or approvals by any applicable AHJ, the responsibility for obtaining any required inspectors, registration or approvals for the mechanical services is the responsibility of this Division 20 contractor.

2 PRODUCTS

2.1 Not used

3 EXECUTION

3.1 General

- .1 Provide mechanical services to SBO and SOT equipment in accordance with the specification sections applicable to each type of service.

3.2 SBO Equipment Installation

- .1 The general contractor is to receive, unpack and set in place new SBO equipment.
- .2 Review the SBO equipment installation instructions prior to running services; if there is a discrepancy between the Contract Documents and the SBO equipment instructions, notify the Consultant of the specific conflicts and obtain direction on how to proceed.
- .3 Where SBO equipment consists of an assembly of components or sub-assemblies that require running of field interconnecting mechanical services between the equipment components or sub-assemblies, provide these interconnecting services between the components or sub-assemblies of the SBO equipment.

3.3 SOT Equipment Installation

- .1 The general contractor or the trade supplying the SOT equipment is to receive, unpack and set in place the SOT equipment.
- .2 Review the SOT equipment installation instructions prior to running services; if there is a discrepancy between the Contract Documents and the SOT equipment instructions, notify the Consultant of the specific conflicts and obtain direction on how to proceed.
- .3 Provide interconnecting mechanical services between components or sub-assemblies of SOT equipment, unless specified to be provided by other Trades.

3.4 Relocation of Existing Owners Equipment

- .1 Where existing Owner's equipment is to be relocated;
 - .1 inspect the existing Owner's equipment and verify extent of services required including type of service and performance parameters (e.g. pressure, flow rate, temperature). Where necessary, contact the equipment manufacturer to obtain the manufacturers recommended installation instructions.
 - .2 disconnect existing services from the owner's equipment and make those disconnected services safe by, unless otherwise shown:
 - (a) capping-off ductwork above ceilings,
 - (b) capping-off piping services above ceilings (for vertical drops) or within 100 mm (4 in.) of the exterior face of a wall penetration,

- (c) removing control wiring back to the 1st control panel that is to remain.
- .2 Where existing Owner's equipment consists of an assembly of components or sub-assemblies that has field-installed interconnecting mechanical services, remove these interconnecting mechanical services,
- .3 The general contractor is responsible for any further disassembly and for relocation of the SBO equipment to its new location,

3.5 General Requirements for Services

- .1 Provide for the following specific installation requirements in addition to requirements of other Specification sections of Division 20 to 25.
- .2 Provide shut-off valve on each service line close to the equipment. Where flexible connectors are used at the SBO or SOT equipment, located the valves on the building side of the flexible connector.
- .3 Provide vacuum breakers and backflow preventers on potable water connections to SBO and SOT equipment connections, to hose bibs, and on fixture connections without adequate air gaps.
- .4 Provide brass traps complete with cleanout on waste connection for equipment unless waste discharges directly into floor drain or funnel drain.
- .5 Where SBO or SOT equipment has both hot and cold domestic water services, provide a composition disc swing check valves downstream of the hot and cold water service isolation valves, except where it is clear that there is no mixing of hot and cold water within the equipment.
- .6 Where specific mechanical service pipe sizes are not shown, valves and service connections to equipment to be one trade pipe size larger than equipment connection size, and trap and drain size to be one trade pipe size larger than waste connection fitting size on equipment.

3.6 Service Connections to Laundry Equipment

- .1 Laundry equipment is to be supplied and set in place by Equipment Division 11 of the Work.
- .2 Provide mechanical services including water, waste, sanitary vent, compressed air, natural gas, steam and exhaust ventilation, and connections including adaptor tailpieces, traps with cleanouts, valves, and piping,
- .3 Provide shut-off valve on supplies and flexible hose connections on services to and from each piece of equipment.
 - .1 Exception: do not use flexible connections on steam piping.
- .4 Provide water hammer arrestors upstream of domestic water connections, ahead of manual isolation valves.

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

COMMON REQUIREMENTS FOR MECHANICAL INSULATION 20 07 11

1 GENERAL

1.1 Scope

- .1 Common requirements for insulation of mechanical services provided under Division 20 to 25 of the Work. The requirements of this specification section apply to separate specification sections for insulation of ductwork, equipment and piping.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 29 Common Hanger and Support Requirements for Piping
 - .2 20 07 13 Duct Insulation
 - .3 20 07 16 Equipment Insulation
 - .4 20 07 19 Piping Insulation
 - .5 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Ambient:** as applied to temperatures means the interior or outdoor air temperature at time of installation.
 - .2 **Coating:** light-consistency compound for indoor applications used in conjunction with reinforcing membrane, to provide either a breathable or vapour barrier finish to insulation.
 - .3 **Cold services:** means cold ductwork, equipment and/or equipment.
 - (a) **Cold ductwork:** mechanical ductwork with a service temperature greater than 1°C and up to and including 16°C (34°F to 61°F).
 - (b) **Cold equipment:** mechanical equipment with a service temperature of 16°C (61°F) or less,
 - (c) **Cold piping:** mechanical piping with a service temperature of 16°C (61°F) or less,
 - .4 **Concealed (services):** mechanical services that are located: in the space above opaque suspended ceilings; within trenches not located in service rooms; within pipe and/or duct shafts; or in non-accessible chases and wall cavities.
 - .5 **Conditioned air:** air supplied from air handling units that heats, cools, dehumidifies, or humidifies the air.
 - .6 **Conditioned space:** an enclosed space or room that is heating, cooled, dehumidified and/or humidified.
 - .7 **Dual temperature services:** means dual temperature ductwork, piping and/or equipment that operates, at different times, at both hot and cold temperatures.
 - (a) **Dual temperature ductwork:** mechanical ductwork that operates at temperatures greater than 1°C and up to and including 38°C (34°F to 100°F), at different times or at different locations in the duct system and includes cooling systems with terminal reheat.
 - (b) **Dual temperature equipment:** means mechanical equipment that operate, at different times, at cold equipment temperatures and at hot equipment temperatures.

- (c) **Dual temperature piping:** mechanical piping that operate, at different times, at cold piping temperatures and at hot piping temperatures.
- .8 **Ductwork:** includes ducts, fans, air handling equipment casings, and plenums.
- .9 **Exposed (services):** mechanical services that are located in areas that are not "concealed" as defined above for concealed services. For greater certainty, the following locations are exposed services:
 - (a) services in tunnels,
 - (b) services in space beneath raised floors.
 - (c) trenches located in service rooms.
- .10 **Finish covering:** a field-applied protective layer for insulation that provides an aesthetic finish but that may also provide mechanical-impact protection, weather-protective, moisture and/or vapour barrier protection.
- .11 **Hot services:** means hot ductwork, equipment and/or equipment.
 - (a) **Hot ductwork:** mechanical ductwork with a service temperature greater than 28°C and up to and including 65°C (80 to 150°F) and does not have any mechanical cooling.
 - (b) **Hot equipment:** mechanical equipment with a service temperature 38°C (100°F) and greater.
 - (c) **Hot piping:** mechanical piping at service temperatures as shown in Table 1 of specification section 20 07 19.
- .12 **Jacket:** a factory-applied material used to contain insulation and may function as a vapour barrier. Jacketed insulation may also be further protected by covering with a finish covering.
- .13 **Mastic:** heavy-consistency waterproof compound for outdoor applications, used in conjunction with reinforcing membrane that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish for outdoor insulation.
- .14 **Mechanical services:** equipment, piping, ductwork and related accessories provided under Division 20 to 25 of the Work.
- .15 **Outdoor (services):** mechanical services located outside of the building envelope including services located beneath overhangs, located in unconditioned soffits, or exposed to any outdoor condition including temperature, sun exposure, or precipitation.
- .16 **Pure water:** water that has been treated with filtration equipment, including but not limited to reverse osmosis, deionization, ultra-filtration, ultra-violet, distillation or any combination of such or similar equipment, to achieve water quality significantly free of impurities.
- .17 **Service temperature:** the highest (for hot mechanical services) or the lowest (for cold mechanical services) gas or vapour design operating temperature, or the liquid supply operating temperature.
- .18 **Surface temperature:** for the purpose of this specification, has the same meaning as service temperature.
- .19 **Unconditioned (space):** rooms or spaces that are not conditioned spaces, and includes ceiling spaces which are not part of a ceiling return air plenum system.
- .20 **Wet area:** spaces subject to high humidity or where mechanical services may be exposed to direct contact with water, including not limited to: pools, shower rooms, tub rooms, medical device reprocessing, dishwashers, sterilizers, cart-washing, vehicle washing, and emergency showers.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:

- .1 NFPA 90-A Installation of Air-Conditioning and Ventilating Systems
- .2 ASHRAE/IES 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

.3	NFPA 255	Test of Surface Burning Characteristics of Building Materials
.2	Product standards:	
.1	CAN/ULC-S102	Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
.2	CAN/ULC-S102.2	Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
.3	CAN/ULC-S114	Standard Method of Test for Determination of Non-Combustibility in Building Materials
.4	ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
.5	ASTM B240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
.6	ASTM C177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus
.7	ASTM C411	Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
.8	ASTM C449	Standard Specification for Mineral Fibre Hydraulic-Setting Thermal Insulation and Finishing Materials
.9	ASTM C518	Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flow Meter Apparatus
.10	ASTM C533	Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
.11	ASTM C534	Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
.12	ASTM C547	Standard Specification for Mineral Fiber Pipe Insulation
.13	ASTM C552	Standard Specification for Cellular Glass Thermal Insulation
.14	ASTM C553	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
.15	ASTM C591	Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
.16	ASTM C612	Standard Specification for Mineral Fiber Block and Board Thermal Insulation
.17	ASTM C795	Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
.18	ASTM C1126 (Gr.1)	Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation
.19	ASTM C1290	Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
.20	ASTM C1393	Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks
.21	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
.22	CGSB 51-GP-52MA	Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.

.23 CGSB 51.53-95 Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.5 Qualified Tradespersons

- .1 Work to be performed by a recognized specialist firm with an established reputation in this field.

Standard of Acceptance

- Custom Insulation Systems
- White & Greer Co Ltd
- Thermax Environmental Inc.
- ICON Insulation Inc.

1.6 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials in one bound submission;
- .1 insulation,
 - .2 coatings, mastics, and sealants,
 - .3 reinforcing membranes,
 - .4 finish covering materials,
 - .5 PVC fitting covers.
- .2 Submit an installation detail drawing indicating how insulation, coatings and vapour barriers are applied in general, and specifically for pipe fittings and equipment insulation.

1.7 Quality

- .1 Manufacturers and products are listed in this section to establish quality and manufacturing standards. Products from other manufacturers with explicitly similar characteristics may be acceptable but must be submitted as an alternative product submission.

2 PRODUCTS

2.1 General Requirements

- .1 Adhesives, coatings, finish coverings, lagging, sealers, and tapes:
- .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

2.2 Adhesives, Fasteners, and Tape

- .1 Contact bond cement:
- .1 for quick setting for metal surfaces.
 - .2 Volatile Organic Content: maximum 80 g/L.
- ### *Standard of Acceptance*
- Bakor - fig. 220-05
 - Foster – fig. Drion 85-75
- .2 Adhesive for flexible closed cell foam insulation:
- .1 Volatile Organic Content: maximum 80 g/L.

Standard of Acceptance

- Armacell - Armaflex 520 BLV
- Armacell - Armaflex. Low VOC Spray Contact Adhesive

.3 Lap seal adhesive:

- .1 for joints and lap sealing of vapour barriers.
- .2 Volatile Organic Content: maximum 250 g/L.

Standard of Acceptance

- Bakor - fig. 220-05
- Childers - fig. CHIL-STIX FRN CP-82

.4 Fibrous insulation adhesive:

- .1 Volatile Organic Content: maximum 250 g/L

Standard of Acceptance

- Childers - fig. CHIL-STIX FRN CP-82
- Foster - fig. 85-70

.5 Vapour barrier tape:

- .1 colour matched and foil faced
- .2 listed to UL 181A.

Standard of Acceptance

- Johns Manville - fig. Zeston Z-Tape
- MacTac Canada Ltd – fig. Vinyl Scrim or Foil Scrim Kraft
- Compac Corp.
- Fattal Canvas Inc. - fig. Insultape

.6 Weld pins, studs, clips and washers:

- .1 Galvanized steel or copper plated steel, stainless steel or aluminium to match ductwork material.
- .2 Attachment method:
 - (a) welded for outdoor ducts,
 - (b) welded for indoor ducts,
 - (c) self-adhesive base may be used for vertical surfaces of rectangular ducts.

Standard of Acceptance

- Midwest - fig. Fasteners
- Jordahl - fig. Studwelding

.7 Staples:

- .1 Monel, flare type, minimum size 12 mm (½ in).

.8 Tie wire:

- .1 1.6 mm (16 ga) stainless steel with twisted ends.

.9 Caulking for sheetmetal finish covers (outdoor use only)

- .1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.

Standard of Acceptance.

- Foster - fig. 95-44

2.3 Coatings and Reinforcing Membranes

.1 Reinforcing membrane:

.1 synthetic fibre:

- (a) Leno weave,
- (b) indoor and outdoor use.

Standard of Acceptance

- ° Foster - fig. Mast-A-Fab

.2 glass-fibre fabric:

- (a) indoor use.

Standard of Acceptance

- ° Childers - fig. Chil-Glas #5/#10

.3 glass-fibre fabric for use with elastomeric closed cell foam:

- (a) indoor use.

Standard of Acceptance

- ° Childers - fig. Chil-Glass #10

.2 Breather coating - Indoors:

- .1 for breather coatings and lagging adhesive,
- .2 Volatile Organic Content: maximum 50 g/L
- .3 white in colour,

Standard of Acceptance

- ° Childers- fig. CP-50A HV2
- ° Foster - fig. 30-36

.3 Breather mastic - Outdoors:

- .1 for breather coatings and lagging adhesive,
- .2 abrasion resistive, flexible,
- .3 UV stabile,
- .4 grey in colour.

Standard of Acceptance

- ° Childers - fig. Vi-Cryl CP-10/11
- ° Foster - fig. 35-00 / 45-00
- ° Bakor - fig. 120-10

.4 Vapor barrier coatings - Indoors:

- .1 Volatile Organic Content: maximum 50 g/L.
- .2 for vapor barrier coatings and lagging adhesive except for elastomeric closed cell foam,
 - (a) permeance rating 0.02 perms maximum,
 - (b) white in colour

Standard of Acceptance

- ° Childers - fig. Chil Perm CP-34/35

- Foster - fig. 30-80, 30-90

.5 Vapor barrier mastic - Outdoors:

- .1 for vapor barrier coatings and lagging adhesive,
- .2 asphalt cutback,
- .3 permeance rating 0.02 perms maximum,
- .4 grey in colour.
- .5 for outdoor use only.

Standard of Acceptance

- Childers - fig. Chil-Pruf CP-22
- Foster - fig. 60-25/60-26

.6 Vapour barrier coatings – elastomeric foam insulation:

- .1 for indoor and outdoor use,
- .2 water bases sealer/finishing coat, water and UV resistant.
- .3 white in colour.

Standard of Acceptance

- Armacell - fig. ArmaFlex WB Finish

2.4 Insulation Finishing Cement

- .1 Mineral fibre, hydraulic-setting insulation cement, to ASTM C449
- .2 Temperature rating: 650°C (1200°F)

Standard of Acceptance

- Johns Manville - fig. CalCoat-127
- Ramco Insulation - fig. Ramcote 1200 (PKI Quick Cote)

2.5 Field Applied Coverings

.1 Fabric finish covering:

- .1 plain weave cotton fabric at 220 g/m2 (6 oz/sq yd), treated with fire retardant lagging adhesive, or
- .2 re-wettable fiberglass lagging fabric with water activated self-adhesive.
- .3 suitable for field painting.

Standard of Acceptance

- Fattal - fig. Thermocanvas
- Clairmont - fig. Diplag 60
- Newtex - fig. Zetex Rewettable

.2 PVC finish covering:

- .1 PVC sheeting, or pre-cut and rolled sheeting to suit OD of pipe and insulation, with UV inhibitor for white colour product,
 - (a) minimum thickness:
 - i) indoors: 0.5 mm (20 mil-in.),
 - ii) outdoors: 0.8 mm (30 mil-in.),
 - (b) maximum operating temperature: 66°C (150°F) at the material,

- (c) listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .2 PVC fitting covering with integral insulation inserts:
 - (a) minimum 0.5 mm (20 mil-in) thickness,
 - (b) pre-molded fitting covers, one or two piece,
 - (c) maximum operating temperature: 66°C (150°F) at the material,
 - (d) self-sealing longitudinal joints or field applied sealer adhesive,
 - (e) listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .3 colour: white:
- .4 foam-glass or glass-fibre insulation molded insert, including for elbows, tees, valves, end-caps, and mechanical pipe couplings,
- .5 multiple layers where required for thicker pipe insulation thicknesses.
- .6 pressure sensitive, colour matching vinyl tape.

Standard of Acceptance

- Johns Manville - fig. Zeston 2000
- Proto PVC - fig. LoSMOKE
- ACWIL Insulations
- Sure Fit Systems

- .3 Metal finish covering:
 - .1 straight pipe, duct or plenum:
 - (a) stucco embossed aluminum 3105 or 3003 to ASTM B-209, not less than 0.45 mm (0.016 in) thick sheet, with integral 3 mil polyfilm moisture barrier on the interior surface, lock-forming quality,
 - (b) stainless steel type 304 to ASTM A-240, not less than 0.25 mm (0.010 in) thick sheet, lock-forming quality;
 - i) stucco embossed,
 - ii) 0.19 mm (3/16 in) corrugated.
 - .2 fittings:
 - (a) custom made swaged ring or lobster back covers on bends and die shaped fitting covers over pipe fittings, round duct fittings, valves, strainers, flanges, and grooved couplings.
 - .3 bands:
 - (a) 12 mm (½ in) wide stainless steel with mechanical fasteners.

Standard of Acceptance

- Alcan Canada Products - fig. Thermaclad Type 1
- Childers Products Inc. - fig. Fab Straps
-

- .4 Protective finish for elastomeric cellular foam insulation
 - .1 indoors and outdoors:

Standard of Acceptance

- Armaflex WB Finish

2.6 Insulation

- .1 Refer to specification sections for duct, equipment, and piping insulation.

3 EXECUTION

3.1 General Requirements

- .1 Apply insulation after pressure and leakage testing is completed and accepted, and heat tracing (if any) is installed.
- .2 Surfaces to be clean and dry before application of insulation.
- .3 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by the product manufacturers.
- .4 Do not apply insulation on chrome plated surfaces of piping, valves, fittings, and equipment.
- .5 Cut and bevel insulation around nameplates and pressure vessel certification stamps, seals or similar markings.
- .6 Neatly finish insulation at supports, protrusions, and interruptions.
- .7 Where insulation media is exposed, seal the insulation with reinforced vapor barrier or breather coating or mastic.

3.2 Installation of Insulation

- .1 Refer to specification sections for duct, equipment, and piping insulation.

3.3 Sealing of Insulation – General Requirements

- .1 The following requirements apply to all mechanical insulation unless otherwise specified in each mechanical service insulation specification section. Refer to separate specifications for specific sealing requirements for ductwork, equipment and piping insulation.
- .2 Apply sealer coatings and mastic in accordance with the following:
 - .1 use breather coating/mastics for hot services:
 - .2 use vapour barrier coating/mastic for cold and dual temperature services:
 - .3 only use mastics on outdoor installations.
 - .4 apply mastics and coatings when ambient temperature is above 4°C (40°F), unless manufacturer's instructions permit colder ambient installation conditions.
- .3 Maintain integrity of vapour barrier through sleeves, around fittings and at hangers and supports.

3.4 Insulation Finish Coverings

- .1 Where required to be provided by other mechanical insulation specification sections, install protective finish coverings in accordance with the following.
- .2 Install protective finish coverings on insulation after breather and vapor barrier sealing is completed.
- .3 For hot services that are exposed in wet areas, secure and seal coverings in accordance with the requirements for cold and dual temperature services.
- .4 Cut finish covering materials to allow 50 mm to 100 mm (2 in to 4 in) overlaps onto adjacent sheets. On vertical services, arrange circumferential overlaps to be on the lower end of each cover section.
- .5 PVC finish covering:
 - .1 Adhesives and sealers to be compatible with PVC material.

- .2 Hot services;
 - (a) secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudinal and circumferential edges,
 - (b) except in wet areas, do not seal major joint edges with vapour barrier tape,
 - (c) seal PVC fitting covers at throat and heel seams by stapling and secure over adjacent insulation covers by banding or taping ends to adjacent finish covering with colour matched tape.
 - (d) Install PVC covers in accordance with the requirements for cold and dual temperature services.
- .3 Cold and dual temperature services:
 - (a) seal longitudinal edges with vapor barrier coating adhesive or colour matched vapour barrier tape for the full length and depth of the overlap,
 - (b) seal circumferential butt edges of PVC fitting covers with reinforced vapour barrier coating adhesive extending over adjacent pipe insulation section with an overlap of at least 50 mm (2 in),
 - (c) seal PVC fitting covers at throat and heel seams by solvent bonding and secured over insulation with reinforced vapor barrier coating overlapping adjacent service insulation a minimum of 50 mm (2 in),
 - (d) neatly finish exposed edges with vapour barrier sealant/mastic.
- .6 Metal finish covering:
 - .1 use stucco embossed metal finish covers on round surfaces with diameter of 2.4 m (8 ft) and smaller; refer to applicable duct, equipment and piping specification sections for metal type.
 - .2 use corrugated stainless steel metal finish covers on flat surfaces, and on round surfaces with diameters greater than 2.4 m (8 ft).
 - .3 apply metal finish coverings over mechanical services, with a 60 mm (2-1/2 in) overlap,
 - .4 use lock-on systems or secure sheeting with bands 450 mm (18 in) apart.
 - .5 make-up curved surfaces with custom made swaged ring or lobster back covers.
 - .6 for indoor mechanical services;
 - (a) seal cover joints for cold and dual temperature services with clear or colour-matched calking.
 - .7 on outdoor mechanical services;
 - (a) seal cover joints for cold and dual temperature services with clear or colour-matched calking to permit expansion of metal finish covers.
- .7 Fabric finish covering:
 - .1 Cotton lagging:
 - (a) apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the piping system, and finish to provide a smooth surface free of wrinkles and sags.
 - (b) where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for cold and dual temperature services.
 - .2 Fiberglass lagging:
 - (a) apply re-wettable fiberglass lagging in accordance with manufacturer instructions, and finish to provide a smooth surface free of wrinkles and sags.
 - (b) for cold and dual temperature services, apply a finish coat of vapour barrier sealer.

- (c) where re-wettable fiberglass lagging is used this satisfies the requirements of a breather coating for hot piping systems,

3.5 Mechanical Damage Protection - Indoors

- .1 Protect visible pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) thick stainless steel protection shield approximately 100 mm (4 in) high, secured to floor slab. Conceal fastenings by use of a floor plate.
- .2 For piping systems using finishes, this protection cover is in addition to the specified pipe finish cover.

3.6 Field Quality Control

- .1 The Consultant reserves the right to have protective finish coverings removed on up to 1% of all cold service and dual temperature service surfaces, fittings, flanges, couplings, valves, and ductwork/pipeline accessories to review the installation of the insulation, at no additional cost.
- .2 If insulation sealing is found to be incorrect at any one sampled location, remove the protective finish on all fittings, flanges, couplings, valves, and pipeline accessories for review, at no additional cost.
- .3 Repair defective insulation sealing and replace protective coverings at no additional cost.

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

DUCTWORK INSULATION

20 07 13

1 GENERAL

1.1 Scope

- .1 Provide insulation, coatings, finish coverings and mechanical protection for ducts, casing, plenums, fans and associated equipment.
- .2 insulation is not required on factory insulated casings and/or over acoustically lined ductwork except as otherwise shown.
- .3 Conform to specification section 20 07 11 for common requirements for mechanical insulation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 07 11 Common Requirements for Mechanical Insulation
 - .2 23 31 13 Metal Ducts.

1.3 Submittals

- .1 Submit shop drawing details for construction of insulation for outdoor ducts, including details for
 - .1 sloping of insulation,
 - .2 installation of vapour barrier/breather coats, and protective finish covering details,
 - .3 reinforcing sheeting for larger ducts.

2 PRODUCTS

2.1 General Requirements

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
 - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84,
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84,
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

2.2 Ductwork Insulation

- .1 Type D-1 (glass-fibre roll blanket):
 - .1 flexible glass-fibre blanket, formaldehyde-free to ASTM C1290,
 - .2 density: 12 kg/m³ (0.75 pcf),
 - .3 service temperature with jacketed: up to 65°C (150°F),
 - .4 foil skim kraft ("FSK") jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
 - .5 vapour transmission: maximum 0.02 perms to ASTM E96 Procedure A,
 - .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
 - .7 minimum RSI values at a mean temperature of 24°C (75°F) at the pre-installed nominal insulation thickness:

Nominal Thickness mm (in)	RSI m ² .°C/W	Nominal Thickness mm (in)	RSI m ² .°C/W
25 (1)	0.53	55 (2.2)	1.06
40 (1.5)	0.74	110 (4.4)	2.11

Standard of Acceptance

- Johns Manville - Microlite FSK Duct Wrap
- Owens Corning - SOFTR Duct Wrap
- Knauf Fibreglass - Atmosphere Duct Wrap

.8 Same as above except provided with a PSK (polypropylene-scrim-draft) vapour barrier jacket.

Standard of Acceptance

- Johns Manville - Microlite Black PSK

.2 Type D-2 (rigid glass fibre board):

.1 rigid glass-fibre insulation board to ASTM C612,

.2 density:

(a) indoors: 48 kg/m³ (3.0 lb./ft³),

(b) outdoors: 96 kg/m³ (6.0 lb./ft³),

.3 service temperature:

(a) unfaced board: up to 232°C (450°F),

(b) faced board: up to 65°C (150°F),

.4 foil skim kraft ("FSK") jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,

.5 vapor transmission: maximum 0.02 perms,

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 minimum RSI values at a mean temperature of 24°C (75°F) at the specified insulation thickness:

Nominal Thickness mm (in)	RSI m ² .°C/W	Nominal Thickness mm (in)	RSI m ² .°C/W
25 (1)	0.76	50 (2)	1.51
40 (1-1/2)	1.14	75 (3)	2.27

Standard of Acceptance

- Johns Manville - Manville 814 Spin-Glas
- Owens Corning - 703 Board
- Knauf Fiberglass - Insulating Board

.3 Type D-3 (mineral fibre board, high temperature)

- .1 rigid-board, mineral fibre to ASTM C411,
- .2 density: 145 kg/m³ (9.1 lb./ft³),
- .3 service temperature: up to 700°C (1292°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
100	0.044	700	0.158

Standard of Acceptance

- ° Roxul - ProRox SL 980

3 EXECUTION

3.1 Applicable Systems to be Insulated

- .1 Insulate ductwork, plenums, casings and equipment in accordance with the following, and of the insulation type and thickness in accordance with Table 1 at the end of this specification section.
- .2 Externally insulate casings and equipment:
 - .1 air handling units producing conditioned supply air,
 - .2 air handling units conveying exhaust air downstream of heat recovery devices,
 - .3 free-standing supply air fans (not enclosed in a casing or plenum).
- .3 Externally insulate ductwork and plenums:
 - .1 cold and dual temperature ductwork conveying conditioned supply air including downstream of reheat coils,
 - .2 hot ductwork conveying conditioned supply air up to the space served but not within the space itself,
 - .3 unconditioned supply air ducts and plenums located in unheated spaces,
 - .4 return air and exhaust air ducts and plenums in unheated spaces,
 - .5 outside air intake ducts and plenums,
 - .6 exhaust air plenums at point of discharge to outside of building,
 - .7 exhaust air ducts and plenums downstream of heat recovery devices,
 - .8 exhaust air ducts between exhaust air damper and point of discharge to outside of building,
 - .9 mixed air plenums and ducts;
 - (a) for recirculating type ventilation systems without cooling coils, terminate outside air intake insulation 300 mm (12 in) downstream of mixing plenum,
 - .10 150 mm (6 in) entering and leaving length overlap of acoustically lined ductwork,
 - .11 sheet metal blank-off plates behind unused sections of air intake louvers.
- .4 Externally insulate ductwork located outdoors:
 - .1 conditioned supply ducts,

- .2 return ducts,
- .3 general and process exhaust ducts between building and rooftop exhaust fan,
 - (a) excluding outdoor fan discharge duct,
- .4 kitchen exhaust ducts between building and rooftop exhaust fan, with more than 3 m (10 ft) length of duct on roof,
 - (a) excluding outdoor fan discharge duct.
- .5 External insulation is not required on:
 - .1 casings, ducts or plenums which have been lined with acoustic insulation, except as described above,
 - .2 ducts, plenums, casings and freestanding supply fans conveying unconditioned air,
 - .3 portions of intake ducts or plenums, unit casings and conditioned air plenums which are of double wall insulated construction,
 - .4 factory insulated flexible ducts,
 - .5 factory insulated air handling units,
 - .6 for non-recirculating make-up air type ventilation systems with a supply air temperature less than 27°C (80°F),
 - (a) terminate casing insulation 300 mm (12 in) downstream of heating coil or heating unit, and
 - (b) insulation is not required on the supply ductwork.

3.2 Installation of Rigid Insulation - Indoors

- .1 Attach insulation fastener pins, studs and clips to all surfaces of ducts, casings, plenums and fans, at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. Attachment method:
 - .1 welded type for outdoor ducts,
 - .2 welded type for indoor ducts,
 - .3 self-adhesive base type may be used for vertical surfaces of rectangular ducts.
- .2 Install rigid board insulation with joints staggered and tightly butted and no visible gaps. Install horizontal boards to overlapping over vertical boards.
- .3 Secure rigid insulation by impaling on insulation fastener pins, apply speed washers and cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.
- .4 Where space restrictions do not permit the use of mechanical fasteners, secure the insulation with 100% coverage of contact adhesive along with stainless steel banding on 300 mm (12 in) centers, with a band within 50 mm (2 in) of each duct corner.
- .5 Neatly finish insulation at supports, protrusions, and interruptions.
- .6 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket. Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.

3.3 Installation of Rigid Insulation - Outdoors

- .1 Secure rigid insulation for ducts and plenums located outdoors as specified for indoor rigid insulation, and as follows.
- .2 Build-up and slope insulation on top of rectangular and flat oval ducts to provide drainage and prevent ponding of water on top of the duct. Without limiting the preceding, as a minimum this includes the following work:
 - .1 provide inserts between the duct and the duct insulation, to raise the insulation to establish the required slope,
 - .2 fabricate inserts from the same material as the duct insulation, shaped to establish the required slope and to provide continuous support to the insulation. Alternatively, inserts may be fabricated from layers of high-density polystyrene insulation equal to Owens Corning Celfort 300,
 - .3 where indicated in the following table for wider ducts, locate the peak of the insulation at the midpoint of the duct and slope the insulation to both sides of the duct,
 - .4 the insert rise height shall be the greater of that determined by the minimum slope and the minimum rise height as shown in the following table.

Duct Width mm (in)	Number of Slope Directions	Minimum Slope (Rise: Run)	Minimum Rise Height
≤ 600 (24)	1	1:12	50 mm (2 in)
>600 and ≤1200 (>24 and ≤48)	2	1:12	50 mm (2 in)
>1200 and ≤2400 (>48 and ≤96)	2	1:25 and reinforced	50 mm (2 in)
>2400 (96)	2	1:25 and reinforced [Note 1]	100 mm (4 in)

Notes:

[1] Refer to specification section 23 31 13 on requirements for provision of a snow and rain roof for large ducts of this size.

- .5 Where required by the preceding table, reinforce the insulation as follows:
 - (a) cover the insulation on top of the duct with reinforcing sheeting, which is separate from any protective finish covering. Install the insulation components in layers as follows:
 - i) protective finish coating,
 - ii) reinforcement
 - iii) vapour barrier/air barrier
 - iv) insulation
 - v) insulation slope inserts
 - (b) fabricate the reinforcement sheet from minimum 0.55 mm (0.022 in.) thick galvanized steel sheet, reinforced with 20 mm (3/4 in) deep V-breaks on 300 mm (12 in) centers,
 - (c) place the steel sheets with the V-breaks/angles pointed down and orientated to run in the direction of the slope,
 - (d) size the width of the reinforcement panel to stop 25 mm (1 in) from the edge of the duct insulation, so as not to interfere with or damage the insulation vapour barrier or protective finish covering,
 - (e) secure the reinforcement sheet to the insulation with 100 x 100 mm (4 x 4 in) wide strips of SAWB along the top and bottom edges of the sheet (parallel to the duct run),

- (f) where SAWB protective finish covering is used, provide 100 x 100 mm (4 x 4 in) wide strips of SAWB over the V-breaks before applying the protective finish covering.

- .3 Where two layers of insulation are used;
 - .1 apply the first layer of insulation without integral vapour barrier jacket,
 - .2 apply the second layer of insulation with integral vapour barrier jacket,
 - .3 stagger the joints so that no second layer joints are within 100 mm (4 in) of an underlying first layer joint.

3.4 Installation of Flexible Insulation – Indoors

- .1 On rectangular ducts 600 mm (24 in) and wider, and round ducts 450 mm (18 in) and wider, attach mechanical fastener pins, studs and clips to the bottom exterior surface of the duct at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. For round ductwork, the bottom of the duct is measured as being half the circumference of the duct.
- .2 Cut flexible insulation to required circumferential length and pull-out to final installed thickness in accordance with manufacturer instructions, and to overlap insulation 50 mm (2 in) on each lap joint, and tightly butt end edges together.
- .3 Secure flexible insulation by:
 - .1 impaling on mechanical fastener pins and secure with speed washers, and either;
 - (a) secure insulation with stainless steel wire or stainless steel banding on 300 mm (12 in) centers, or by stapling laps, or
 - (b) secure insulation with 100% insulation adhesive coverage.
- .4 Cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.
- .5 Neatly finish insulation at supports, protrusions, and interruptions.
- .6 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket. Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.
- .7 Use flexible insulation with black PSK jackets in the following exposed locations:
 - .1 • Exposed ductwork requiring insulation

3.5 Installation of Flexible Insulation – Outdoors

- .1 Flexible insulation is only permitted for use outdoors on round ducts, and on the rounded sides of flat-oval duct.
- .2 Secure flexible insulation for round or ducts located outdoors as specified for indoor flexible insulation, and as follows.
- .3 Secure insulation with stainless steel banding on 300 mm (12 in) centers.

3.6 Insulation of Fittings, Flanges and Accessories

- .1 Cut and miter rigid insulation at elbows and fittings and attach to ductwork with mechanical fasteners as specified for ducts, and in addition secure insulation with 50% coverage of adhesive.
- .2 At junctions between external insulation and acoustically lined ducts, overlap external insulation 300 mm (12 in) over acoustically lined ducts.

- .3 Insulate flanges, support angles and standing seams with 100 mm (4 in) wide overlapping strips of insulation matching adjacent ductwork and of same thickness, and seal with two coats of breather mastic with reinforcing membrane.

3.7 Sealing Insulation - Hot Ductwork

- .1 Seal hot ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
 - .1 apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,
 - .2 do not tape longitudinal lap seams except as required to secure the insulation.
- .3 Indoor installations – wet areas:
 - .1 apply vapour barrier tape to:
 - (a) all longitudinal lap seams and butt edges,
 - (b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.
 - (c) over insulation fasteners including pins/washers and staples.
- .4 Outdoor installation:
 - .1 apply two coats of breather mastic with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket,
 - .2 cover mechanical fastener penetrations including staples with two coats breather mastic with reinforcing membrane.

3.8 Sealing Insulation - Cold and Dual Temperature Ductwork

- .1 Seal cold and dual temperature ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
 - .1 tightly seal insulation lap seams and butt joints, using factory lap seams or field-fabricated lap seams and butt strips,
 - .2 apply vapour barrier tape to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side,
 - .3 cover insulation pin/washer fastener penetrations including staples with vapour barrier tape overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.
- .3 Indoor installation – wet areas:
 - .1 tightly seal ductwork located within wet areas in accordance with the requirements for outdoor installation except use vapour barrier coatings.
- .4 Outdoor installation:
 - .1 apply two coats of vapour barrier mastic with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket,
 - .2 cover mechanical fastener penetrations including staples with two coats vapour barrier mastic with reinforcing membrane, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.

3.9 Insulation Finish Covering

- .1 Provide insulation protective finish coverings selected in accordance with Table 2 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.
 - .1 for round ducts,
 - (a) do not place an overlap within one-eighth duct diameter on each side of the duct top centerline,
 - (b) overlap higher layers over lower layers with an overlap not less than 100 mm (4 in).

3.10 Painted Ductwork

- .1 Finish ductwork with fabric finish for the following systems:
 - .1 exposed ductwork in public areas including,
- .2 Prime and top-coat painting is provided under separate Division of the Work.

3.11 Mechanical Damage Protection - Indoors

- .1 Protect exposed insulated ductwork from floor level up to a height of 1200 mm (4 ft) above the floor with 0.9 mm (20 ga.) galvanized steel jacket, with riveted longitudinal seams and mechanically fastened to the floor with countersunk stainless steel screws.
- .2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.

3.12 Insulating and Finishes Tables

- .1 The insulating and finishing tables follow:
 - .1 Table 1 - Ductwork, Insulation Type and Thickness
 - .2 Table 3 - Ductwork Insulation Protective Finishes.

Table 1:
Ductwork Insulation Type and Thickness

Duct Nominal Air Temperature	Location	Equipment Description	Insulation Type	Insulation Thickness mm (in) [Note 1]
5°C to 65°C (40 to 150°F)	Indoors	Air handling unit casings and plenums, Free standing supply fans	D-2	50 (2)
		Rectangular ducts and plenums – exposed or concealed	D-2	25 (1)
		Rectangular ducts - concealed	D-1	25 (1)
		Round and Oval ducts - exposed		
	Unconditioned Space	Rectangular ducts and plenums	D2	40 (1-1/2)
			D1	55 (2.2)
		Round and Oval ducts	D1	55 (2.2)
	Outdoors	Rectangular and Oval – Supply, Return	D-2	75 (3)
		Round and Oval – Supply, Return	D-1	110 (4.4) [Note 2, 3]
		Rectangular – Process and General Exhaust	D-2	1 (25)
		Round – Process and General Exhaust	D-1	1.5 (40)
		Rectangular - Kitchen Exhaust	D-3	50 (2)

.... continued on next page

Table 1: (continued)
Ductwork Insulation Type and Thickness

Duct Nominal Air Temperature	Location	Equipment Description	Insulation Type	Insulation Thickness mm (in) [Note 1]
-40 to +40°C (-40 to 104°F)	Indoors	Plenums and Casings – Air Intakes	D2	Two layers 50 (2)
-10 to +40°C (14 to 104°F)	Indoors	Plenums and Casings – Exhaust	D2	50 (2)
5 to 16°C	Indoors	Drain Pans	D2	1 (25)

Notes:

[1] Type D-1 flexible duct insulation thickness is “out of box” before installation.

[2] Insulation thickness may be provided by two layers, so that the total insulation thickness “out of the box” is equal to or greater than the specified thickness.

[3] Flexible duct may be used only on the rounded sides of flat oval ducts.

Table 2:
Ductwork Insulation Protective Finish Coverings

Location	Exposed/ Concealed	System/ Space	Protective Finish Covering
Indoors	Concealed	All	None
	Exposed	Service Rooms	Fabric
		Public Spaces	Fabric
Outdoors	Any	All	Metal

End of Section

EQUIPMENT INSULATION

20 07 16

1 GENERAL

1.1 Scope

- .1 Provide insulation, coatings, finish coverings and mechanical protection for heating and cooling equipment.
- .2 Provide insulation on the back-side of radiant ceiling panels.
- .3 Insulation is not required on factory insulated equipment.
- .4 Conform to specification section 20 07 11 for common requirements for mechanical insulation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 07 11 Common Requirements for Mechanical Insulation

2 PRODUCTS

2.1 General Requirements

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
 - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84,
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84,
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building.

2.2 Equipment Insulation

- .1 Type E-1 (glass fibre, semi-rigid roll):
 - .1 glass fibre semi-rigid roll insulation for tanks and pipes, to ASTM C1393 or ASTM C177,
 - .2 glass-fibre oriented to maintain uniform thickness when installed on round surfaces,
 - .3 density: 40 kg/m³ (2.5 lb/ft³),
 - .4 nominal pipe size: NPS 14 and larger,
 - .5 service temperature, jacketed: up to 65°C (150°F),
 - .6 jacket: integral all-service-jacket (ASJ) of white kraft paper bonded to aluminum foil substrate reinforced with tri-directional fiber-glass scrim.
 - .7 vapor transmission: maximum 0.02 perms to ASTM E96,
 - .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
 - .9 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	93	0.046

Standard of Acceptance

- Johns Manville - Micro-Flex Pipe and Tank Wrap
- Owens Corning - Fiberglas Pipe and Tank
- Knauf Fibreglass - KwikFlex Pipe and Tank

.2 Type E-2 (glass fibre, rigid board):

- .1 rigid glass-fibre insulation board to ASTM C612,
- .2 density:
 - (a) indoors: 48 kg/m³ (3.0 lb/ft³),
 - (b) outdoors: 96 kg/m³ (6.0 lb/ft³),
- .3 service temperature:
 - (a) unfaced board: up to 232°C (450°F),
 - (b) faced board: up to 65°C (150°F),
- .4 jacket: integral foil skim-kraft (FSK) jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .5 vapor transmission: maximum 0.02 perms,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 minimum RSI values at a mean temperature of 24°C (75°F) at the specified insulation thickness:

Nominal Thickness mm (in)	RSI m ² ·°C/W	Nominal Thickness mm (in)	RSI m ² ·°C/W
25 (1)	0.76	50 (2)	1.51
40 (1-1/2)	1.14	75 (3)	2.27

Standard of Acceptance

- Johns Manville - Manville 814 Spin-Glas
- Owens Corning - 703 Board
- Knauf Fiberglass - Insulating Board

.3 Type E-3 (mineral fibre, roll)

- .1 mineral wool, roll insulation for tanks and pipes, to ASTM C553,
- .2 density: 90 kg/m³ (5.6 lb/cu ft),
- .3 service temperature: up to 650°C (1200°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
149	0.053	315	0.090

Standard of Acceptance

- Roxul - ProRox MA 960NA

- ° Johns Manville - MinWool-1200 Pipe and Tank

.4 Type E-4 (mineral fibre, semi-rigid roll):

- .1 mineral wool, semi-rigid roll for tanks and pipes, to ASTM C547,
- .2 density: 90 kg/m³ (5.6 lb/cu ft),
- .3 service temperature: up to 650°C (1200°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .6 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
149	0.053	315	0.090

Standard of Acceptance

- ° Johns Manville - MinWool-1200 Field-Formed

.5 Type E-5 (mineral fibre board):

- .1 rigid-board, mineral fibre to ASTM C612,
- .2 density: 95 - 100 kg/m³ (6 - 6.2 lb/ft³),
- .3 service temperature: up to 650°C (1200°F),
- .4 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .5 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .6 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
100	0.045	600	0.175

Standard of Acceptance

- ° Roxul - ProRox SL 960
- ° Johns Manville - MinWool-1200 Industrial Board

.6 Type E-6 (molded mineral fibre):

- .1 factory molded mineral fibre to ASTM C547,
- .2 density: 128 kg/m³ (8.0 lb/ft³),
- .3 equivalent nominal pipe size: NPS 44 and smaller,
- .4 service temperature: up to 650°C (1200°F),
- .5 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .6 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.036	149	0.049

Standard of Acceptance

- Roxul - ProRox PS 960
- Johns Manville - MinWool-1200
- Industrial Fiber-Tek - IFT 1200 Pipe

.7 Type E-8 (elastomeric foam plastic):

- .1 flexible elastomeric closed cell foam, to ASTM C534,
- .2 service temperature: -183°C (-297°F) to 82°C (183°F),
- .3 maximum thickness: 25 mm (1 in),
- .4 manufacturer specific sealer/adhesive,
- .5 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .6 not to exceed a maximum thermal conductivity at 25 mm (1 in) thickness at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	32	0.037

Standard of Acceptance

- Armstrong - AP Armaflex
- Rubatex

.8 Type E-9 (calcium silicate):

- .1 fabricated pipe and fitting shapes, calcium silicate, asbestos-free, to ASTM C533 Type I,
- .2 density: 232 kg/m³ (14.5 lb/cu ft),
- .3 integral corrosion inhibitor to reduce under insulation corrosion,
- .4 nominal pipe size: NPS 4 to NPS 24,
- .5 service temperature: 20 to 649°C (70 to 1200°F),
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.050	93	0.056

Standard of Acceptance

- ° Johns Manville - Thermo-12 Gold

.9 Type E-10 (removable high-temperature insulated jackets):

- .1 custom fabricated, removable/reusable high temperature insulated jackets for hot surfaces,
- .2 suitable for indoor and outdoor use,
- .3 process surface temperature: as shown in Table 1,
- .4 maximum outer jacket touch-safe temperature protection: 95°C (203°F),
- .5 outer jacket: silicone impregnated glass-fibre, for temperatures up to 260°C (500°F),
- .6 insulation: mineral or fibreglass insulation suitable for system operating temperature,
- .7 internal liner: silicone impregnated fibreglass fabric, or stainless steel knitted wire mesh,
- .8 fasteners:
 - (a) stainless steel laced wire, for pipe sections,
 - (b) stainless steel mesh straps with buckle rings, for valves, strainers, meters and similar pipeline accessories,
- .9 metal identification tag, referenced equipment served,
- .10 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .11 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.

Standard of Acceptance

- ° Firwin Corporation
- ° Thermohelp Canada Inc.

.10 E-11 (glass-fibre roll blanket):

- .1 flexible glass-fibre blanket, formaldehyde-free to ASTM C1290,
- .2 density: 12 kg/m³ (0.75 pcf),
- .3 service temperature with jacketed: up to 65°C (150°F),
- .4 jacket: integral foil skim-kraft (FSK) jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .5 vapour transmission: maximum 0.02 perms to ASTM E96 Procedure A,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 minimum RSI values at a mean temperature of 24°C (75°F) at the pre-installed nominal insulation thickness:

Nominal Thickness mm (in)	RSI m ² ·°C/W	Nominal Thickness mm (in)	RSI m ² ·°C/W
25 (1)	0.53	55 (2.2)	1.06
40 (1.5)	0.74	110 (4.4)	2.11

Standard of Acceptance

- ° Johns Manville - Microlite FSK Duct Wrap
- ° Owens Corning - SOFTR Duct Wrap
- ° Knauf Fibreglass - Atmosphere Duct Wrap

3 EXECUTION

3.1 Applicable Equipment

- .1 Insulate hot equipment where the highest service temperature of the equipment is 38°C (100°F) and higher in accordance with Table 1A and 1B at the end of this specification section.
- .2 Insulate cold and dual temperature equipment where the lowest service temperature is 16°C (61°F) or less in accordance with Table 2 at the end of this Section.

3.2 Insulation of Equipment – General Requirements

- .1 Place insulation with joints staggered and tightly butted so that there are no voids.
- .2 Do not use weld pins on plate-and-frame heat exchangers.
- .3 For flat surfaces, and curved surfaces with radius 250 mm (10 in) and greater:
 - .1 secure insulation with stainless steel bands at not more than 300 mm (12 in) spacing, or secure rigid board insulation with adhesive applied in strips 150 mm (6 in) wide at not more than 300 mm (12 in) centers,
 - .2 for boiler breeching,
 - .3 provide metal corner beads to reinforce corners and edges of rectangular breeching.
- .4 For curved surfaces with radius less than 250 mm (10 in):
 - .1 cut insulation with bevels to allow full butt joints to prevent “V” shaped gaps between pieces,
 - .2 secure insulation with stainless steel bands or wire at not more than 300 mm (12 in) spacing, and apply adhesive in strips 150 mm (6 in) wide at not more than 300 mm (12 in) centers,
- .5 For irregular surfaces of equipment, pipe couplings and flanged nozzles;
 - .1 use preformed sections, or mitred segments of rigid board and/or semi-rigid roll insulation secured with stainless wire, or wrap with roll-type insulation to thickness equal to that of adjoining insulation.
- .6 For nozzles, manholes, and access doors:
 - .1 terminate insulation with straight cut with space of 25 mm (1 in) at connection,
 - .2 seal cut of insulation with insulation coatings/mastic beveled away from flanged or union connections,
 - .3 cover flanged joint, union, manhole and access doors with removable and replaceable aluminum insulated box overlapping adjacent insulation by 50 mm (2 in) and secured with bands.
- .7 For instruments and instrument sensor risers:
 - .1 tightly fit equipment insulation to instrument riser/piping,
 - .2 in addition, for cold and dual temperature equipment, insulate the instrument sensor riser for a length equal to four (4) times the diameter of the riser pipe.
- .8 Additional Requirements for Calcium Silicate Insulation
 - .1 Apply using high temperature adhesive.
 - .2 Place insulation in double layers with joints tightly butted and staggered and fill voids and openings in assembly with insulating cement.
 - .3 Secure insulation with 1.6 mm (16 ga) stainless steel wire or bands at not more than 300 mm (12 in) on center. Use welded studs, clips, flanges or angles as anchors for wire and bands.
- .9 For equipment having a surface temperature greater than 121°C (250°F);

- .1 apply insulation finishing cement at all exposed edges of insulation where the insulation is interrupted by valves, connections to other equipment, and equipment supports and anchors.

3.3 Additional Requirements for Selected Hot Equipment

- .1 For field-fabricated breeching and ducting conveying combustion gases from boilers;
 - .1 attach welding-type insulation fastener pins or studs to the exterior surfaces at not greater than 300 mm (12 in) centers, in each direction, but not less than two (2) rows per surface, for the following breeching, duct and pipe services:
 - (a) to the vertical sides and bottom surface of indoor rectangular services that are 600 mm (24 in) and larger,
 - (b) to the bottom half of round services that are 450 mm (18 in) diameter and larger,
 - (c) to all surfaces of services located outdoors,
 - (d) to all surfaces of any portion of a chimney that is located indoors,
 - .2 secure insulation by impaling on pins, apply washers and clip of excess pin length flush to the washer.
 - .3 apply insulation finishing cement at all exposed edges of insulation where the insulation is interrupted by attachments to the breeching including specifically, but not limited to, riser support attachments.
- .2 For radiant ceiling panels, size insulation to fully cover the backside of the panel and to overlap 50 mm (2 in) on each side unless the panel abuts the building construction. Cover the fibre-face and cut edges of insulation with vapour barrier tape so that there are no exposed fibres.

3.4 Additional Requirements for Selected Cold and Dual Temperature Equipment

- .1 Cold pumps:
 - .1 insulate pump casing with elastomeric foam insulation adhered to clean oil-free metal surfaces by compression fit method with full coverage of adhesive.
- .2 Refrigeration machines:
 - .1 insulate evaporator shell with two staggered layers of elastomeric foam insulation adhered to clean oil-free metal surfaces by compression fit method and with full coverage of adhesive,
 - .2 insulate refrigeration lines, oil cooler piping, purge lines, and other parts subject to sweating with 20 mm (¾ in) elastomeric foam insulation pipe type insulation,
 - .3 insulate evaporator heads and water boxes with removable, replaceable insulated boxes consisting of:
 - (a) 1.6 mm (16 ga) aluminum or stainless steel sheeting, with edges and corners caulked and sealed,,
 - (b) lined with two layers of elastomeric foam insulation,
 - (c) apply vapour barrier coating/adhesive between adjacent casing sections after box is in place, and
 - (d) attach boxes so that they may be removed without disturbing casing insulation.
- .3 Plate-and-Frame heat exchangers:
 - .1 insulate frame-heads with two staggered layers of elastomeric foam insulation adhered to clean oil-free metal surfaces by compression fit method and with full coverage of adhesive,
 - .2 insulate plates with removable, replaceable insulated boxes consisting of:
 - (a) 1.6 mm (16 ga) aluminum or stainless steel sheeting, with edges and corners caulked and sealed,

- (b) lined with two layers elastomeric foam insulation,
- (c) apply vapour barrier coating/adhesive between adjacent casing sections after box is in place, and
- (d) attach boxes so that they may be removed without disturbing casing insulation.

3.5 Sealing Insulation - Hot Equipment

- .1 Seal equipment insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation:
 - .1 apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,
 - .2 do not tape lap joints except as required to secure the insulation,
 - .3 sealing of indoor insulation is not required where a protection finish jacket is applied.
- .3 Outdoor installation:
 - .1 apply two coats of breather mastic complete with reinforcing membrane over the entire exposed insulation surface, regardless of final finish jacket application,
 - .2 breather mastics are not required on type E-10 insulation,
 - .3 seal type E-9 insulation with a 100% coverage of insulation finishing cement.

3.6 Sealing Insulation - Cold and Dual Temperature Equipment

- .1 Seal equipment insulation in accordance with specification section 20 07 11 and/except as specified herein.
- .2 All insulation except type E-8 for indoor and outdoor installation:
 - .1 apply two coats of vapor barrier coating/mastic complete with reinforcing membrane over equipment insulation, regardless of final finish jacket application.
 - .2 at pipe connections, cut-back insulation and seal with coating/mastic; insulate pipe flanges in accordance with requirements for piping insulation.
 - .3 at instruments and instrumentation sensor riser, cut-back and seal insulation with coating/mastic at riser, and seal sensor riser insulation.
- .3 Type E-8 insulation:
 - .1 seal transverse and butt joints for type E-8 insulation with sealer/adhesive specific to elastomeric foam insulation,
 - .2 seal type E-8 insulation located indoors and outdoors with white vapour barrier coating for elastomeric foam insulation.

3.7 Insulation Finish Covering

- .1 Provide insulation protective finish coverings selected in accordance with Tables 1 to 3 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.

3.8 Insulating and Finishes Tables

- .1 The insulating and finishing tables follow:
 - .1 Table 1A - Hot Equipment, Insulation Type, Thickness, and Coverings (excluding engines)

-
- | | | |
|----|-------------------|---|
| .2 | Table 1B - | Hot Equipment, Insulation Type, Thickness, and Coverings – For Engine Exhaust |
| .3 | Table 2 Coverings | - Cold and Dual Temperature Equipment, Insulation Type, Thickness and |
| .4 | Table 3 | - Equipment Insulation Protective Finish Coverings |

Table 1A:
Hot Equipment Insulation Type, Thickness, and Coverings (excluding engines)

Equipment Description	Fluid Service Temperature °C (°F)	Insulation Type	Insulation Thickness	Protective Finishing Covering [Note 1]
Steam boiler combustion gases (<u>maximum 1720 kPag</u>): - breeching/venting - chimney connectors - stacks and chimneys inside of building	>120 to ≤ 400 (>248 to ≤ 750)	E-4, E-5	50 (2)	Fabric
			75 (3)	St. Steel Aluminium
Hot water boiler combustion gases (<u>non-condensing</u>): - breeching/venting - chimney connectors - stacks and chimneys inside of building	≥ 38 to ≤ 200 (≥ 100 to ≤ 392)	E-4, E-5	25 (1)	Fabric
			40 (1.5)	St. Steel Aluminium
Hot water boiler combustion gases (<u>condensing</u>): - breeching/venting - chimney connectors	≤ 70 (≤ 160)	None	---	---
Shell-and-Tube Heat exchangers Flash tanks Expansion tanks	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-1, E-3, E-4	50 (2)	Fabric St. Steel Aluminium
Plate-and-frame Heat exchangers	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-2, E-5	25 (1)	
Domestic hot water tank & heaters	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-1, E-3	40 (1½)	
Radiant ceiling panels	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-11	50 (2)	FSK
Any other hot equipment	> 120 to ≤ 260 (> 248 to ≤ 500)	E-4, E-5	50 (2)	Fabric
			90 (3.5)	St. Steel Aluminium
	≥ 38 to ≤ 120 (≥ 100 to ≤ 248)	E-1 to E-6	25 (1)	Fabric St. Steel Aluminium

Notes:

[1] For exposed equipment located indoors. See table 3 for other locations.

Table 1B:
Hot Equipment Insulation Type, Thickness, and Coverings – Engine Exhaust

Equipment Description	Exhaust Gas Service Temperature °C (°F)	1 st Layer Type x Thickness mm (in)	2 nd Layer Type x Thickness mm (in)	Protective Finishing Covering [Note 1]
Natural Gas Engine combustion gas exhaust silencer	≤ 700 (≤ 1292)	E-7 50 (2)	E-4, E-5 90 (3.5)	Fabric
		E-7 50 (2)	E-4, E-5 150 (6) [Note 2]	Stainless Steel
Engine exhaust gas heat exchanger, for natural gas engines	≤ 700 (≤ 1292)	E-7 50 (2)	E-4, E-5 150 (6)	Fabric
Diesel Engine combustion gas exhaust silencer	≤ 540 (≤ 1000)	E-7 50 (2)	E-4, E-5 50 (2)	Fabric
		E-7 50 (2)	E-4, E-5 125 (5)	Stainless Steel
Selective Catalytic Reduction (SCR) reactor chamber (diesel engine exhaust)	≤ 540 (≤ 1000)	E-10 [Note 3]	---	Factory fabric
Engine exhaust gas heat exchanger, for diesel engines	≤ 540 (≤ 1000)	E-7 50 (2)	E-4, E-5 75 (3)	Fabric

Notes:

[1] For exposed equipment located indoors. See table 3 for other locations.

[2] Made up of two equal thickness layers with a total thickness of the indicated value.

[3] Thickness as required for touch-safe temperature on outer surface.

Table 2:
Cold and Dual Temperature Equipment Insulation Type, Thickness, and Coverings

Fluid Service Temperature °C (°F)	Equipment Description	Insulation Type	Insulation Thickness	Protective Finishing Covering [Note 1]
≥ 4 and ≤ 16 (≥ 39 and ≤ 61)	Heat exchangers; plate-and-frame	E-2	2 layers each 20 (3/4)	Fabric
	Chilled water pumps	E-8	25 (1)	None
		E-1, E-2	Removable boxed insulation; 2 layers of 25 (1)	Aluminium or Stainless Steel
	Cooling tower/condenser water pumps (winter free-cooling only)	E-8	12 (1/2)	None
	Chilled water expansion tanks, Glycol cooling system expansion tanks	E-8	20 (3/4)	WB Coating
		E-1, E-3, E-4	25 (1)	Fabric
	Chilled water storage tank	E-8	2 layers each 25 (1)	Stainless Steel
	Indoor cooling tower water basin	E-8	25 (1)	Stainless Steel
	Domestic cold-water booster pumps, Domestic cold-water meter, Domestic cold-water backflow preventers	E-8	12 (1/2)	None
	Evaporative cooling unit sumps	E-8	25 (1)	Stainless Steel
	Equipment not otherwise identified.	E-1, E-2	25 (1)	Fabric
		E-8	20 (3/4)	None
< 4 (< 39)	Refrigeration equipment: evaporator shell and heads	E-8	2 layers each 25 (1)	WB coating
	Refrigeration equipment: liquid refrigerant piping and accessories	E-8	25 (1)	None

Notes:

[1] For exposed equipment located indoors. See table 3 for other locations.

Table 3:
Equipment Insulation Protective Finish Coverings

Location	Exposed/ Concealed	Equipment	Protective Finish Covering
Indoors	Concealed	Hot	None
		Radiant Panels	FSK
		Cold	Fabric
	Exposed	All	See Tables 1A, 1B, 2
Outdoors	Exposed	All	Stainless Steel

End of Section

PIPING INSULATION 20 07 19

1 GENERAL

1.1 Scope

- .1 Provide insulation, coatings, finishing coverings and mechanical protection of piping, valves, fittings, and pipeline accessories.
- .2 Conform to Specification section 20 07 11 for common requirements for mechanical insulation.
- .3 Provide fire rated insulation on piping as shown, including fire protection standpipes. Coordinate with the contractor under Division 21 for location and extent of standpipes to be protected.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other Specification sections, the work under this section directly integrates with or refers to the following Specification sections:
 - .1 20 05 29 Common Hanger and Support Requirements for Piping
 - .2 20 07 11 Common Requirements for Mechanical Insulation

2 PRODUCTS

2.1 General Requirements

- .1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:
 - .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.
 - .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.
 - .3 exception: vapor barrier mastics on mechanical services located outside of the building

2.2 Pipe Insulation

- .1 Type P-1 (molded glass-fibre):
 - .1 factory molded rigid glass-fibre to ASTM C547,
 - .2 nominal pipe size: NPS 24 and smaller,
 - .3 service temperature, jacketed: -18°C (0°F) to 65°C (150°F),
 - .4 jacket: all-service-jacket (ASJ) of white kraft paper bonded to aluminum foil, reinforced with glass fibre yarn, and laminated to an interior kraft paper face,
 - .5 vapor transmission: maximum 0.02 perms to ASTM E96,
 - .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
 - .7 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material,
 - .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.034	93	0.040

Standard of Acceptance

- Johns Manville - fig. Micro-Lok HP (25% recycled content)
- Owens Corning - fig. Fiberglas Evolution (paper-free ASJ)
- Knauf Fiberglass - fig. Earthwool 1000 Ecosse (bio-based binders)

.2 Type P-2 (semi-rigid glass-fibre roll):

- .1 glass fibre semi-rigid roll insulation for tanks and pipes, to ASTM C1393 or ASTM C177,
- .2 glass-fibre oriented to maintain uniform thickness when installed on round surfaces,
- .3 density: 40 kg/m³ (2.5 lb/ft³),
- .4 nominal pipe size: NPS 14 and larger,
- .5 service temperature with jacket: up to 65°C (150°F),
- .6 jacket: all-service-jacket ("ASJ") of white kraft paper bonded to aluminum foil, reinforced with glass fibre yarn, and laminated to an interior kraft paper face,
- .7 vapor transmission: maximum 0.02 perms to ASTM E96,
- .8 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	93	0.046

Standard of Acceptance

- Johns Manville - fig. Micro-Flex Pipe and Tank Wrap
- Owens Corning - fig. Fiberglas Pipe and Tank
- Knauf Fibreglass - fig. KwikFlex Pipe and Tank

.3 Type P-3 (molded mineral fibre):

- .1 factory molded mineral fibre to ASTM C547,
- .2 density: 128 kg/m³ (8.0 lb/ft³),
- .3 nominal pipe size: NPS 30 and smaller,
- .4 service temperature: up to 650°C (1200°F),
- .5 jacket: integral foil skim-kraft (FSK) jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)

38	0.036	149	0.049
----	-------	-----	-------

Standard of Acceptance

- ° Rockwool - fig. ProRox PS 960
- ° Johns Manville - fig. MinWool-1200
- ° Industrial Fiber-Tek - fig. IFT 1200 Pipe

.4 Type P-4 (molded mineral fibre, high temperature):

- .1 factory molded mineral fibre, high temperature, to ASTM C547,
- .2 density: 145 kg/m³ (9.1 lb/ft³),
- .3 nominal pipe size: NPS 6 and larger,
- .4 service temperature: up to 760°C (1400°F),
- .5 jacket: none,
- .6 compressive strength: 53 kPa (8 psi) at 10% compression,
- .7 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.039	149	0.049

Standard of Acceptance

- ° Rockwool - fig. ProRox PS 980

.5 Type P-5 (cellular glass):

- .1 fabricated pipe and fitting shapes, cellular glass to ASTM C552,
- .2 density: 120 kg/m³ (7.5 lb/cu ft),
- .3 nominal pipe size: NPS 16 and smaller,
- .4 service temperature: -268°C (-450°F) to 480°C (900°F),
- .5 jacket: none,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
10	0.040	24	0.042

Standard of Acceptance

- ° Owens Corning - fig. Foamglas

.6 Type P-6 (elastomeric foam plastic):

- .1 flexible elastomeric closed cell foam, tubular with self-sealing seams, to ASTM C534,
- .2 nominal pipe size: NPS 2 and smaller,
- .3 service temperature: -183°C (-297°F) to 82°C (183°F),
- .4 jacket: none,
- .5 manufacturer specific sealer/adhesive,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	32	0.037

Standard of Acceptance

- ° Armacell - fig. AP Armaflex SS Pipe Insulation
- ° KFlex USA - fig. Insul-Tube

- .7 Type P-7 (calcium silicate):
 - .1 fabricated pipe and fitting shapes, calcium silicate, asbestos-free, to ASTM C533 Type I,
 - .2 density: 232 kg/m³ (14.5 lb/cu ft),
 - .3 integral corrosion inhibitor to reduce under insulation corrosion,
 - .4 nominal pipe size: NPS 4 to NPS 24,
 - .5 service temperature: 20 to 649°C (70 to 1200°F).
 - .6 jacket: none,
 - .7 listed to CAN/ULC-S102/S102.2 or ASTM E84,
 - .8 non-combustible to CAN/ULC-S114 or does not flame, glow, smolder or smoke when tested to ASTM C411.
 - .9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.050	93	0.056

Standard of Acceptance

- ° Johns Manville - fig. Thermo-12 Gold

- .8 Type P-8 (removable high-temperature insulated jackets):
 - .1 custom fabricated, removable/reusable high temperature insulated jackets for hot surfaces,
 - .2 suitable for indoor and outdoor use,
 - .3 process surface temperature: as shown in Table 1,

- .4 maximum outer jacket touch-safe temperature protection: 95°C (203°F),
- .5 jacket: silicone impregnated glass-fibre, for temperatures up to 260°C (500°F),
- .6 insulation: mineral or fibreglass insulation suitable for system operating temperature,
- .7 internal liner: silicone impregnated fibreglass fabric, or stainless steel knitted wire mesh,
- .8 fasteners:
 - (a) stainless steel laced wire, for pipe sections,
 - (b) stainless steel mesh straps with buckle rings, for valves, strainers, meters and similar pipeline accessories,
- .9 metal identification tag, referenced equipment served.

Standard of Acceptance

- ° Firwin Corporation
- ° Thermohelp Canada Inc.

.9 Type P-9 (fire-rated pipe insulation):

- .1 foil encapsulated, fire resistant insulation blanket,
- .2 listed to CAN/ULC-S144 for two hour fire resistance rated ducts,
- .3 manufacturer's supporting documentation for protection of piping for fire protection for a period of two hours when exposed to temperatures up to 200°C (392°F) in a sprinklered building,
- .4 listed to CAN/ULC-S102.2.

Standard of Acceptance

- ° Thermal Ceramics – fig. Firemaster FastWrap XL
- ° 3M - fig. Fire Barrier Duct Wrap 615 System

.10 Type P-10 (ceramic wool)

- .1 alkaline earth silicate fibres (AES), roll insulation for tanks and pipes, to ASTM C201,
- .2 free of binders and lubricants,
- .3 density: 96 kg/m³ (6 lb/cu ft),
- .4 continuous service temperature: 1000°C (1830°F),
- .5 jacket: none,
- .6 non-combustible,
- .7 no requirement for labelling under the Global Harmonized System for classification labels for chemicals,
- .8 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
800	0.21	1000	0.29

Standard of Acceptance

- ° Morgan Thermal Ceramics -fig. Superwool Plus

2.3 Pipe Support Inserts

.1 General:

- .1 molded or fabricated high-density molded insulation inserts for pipe supports.

.2 Type P-21 (polyisocyanurate):

- .1 polyurethane modified polyisocyanurate, to ASTM C591, Gr.2, Type IV,
- .2 nominal pipe size: NPS 1-1/2 to NPS 4,
- .3 density: nominal 32 kg/m³ (2 lb/ft³),
- .4 minimum compressive strength perpendicular to pipe surface: 165 kPa (24 psi),
- .5 service temperature: -73°C to +121°C (-100°F to 250°F),
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84.

Standard of Acceptance

- ° Trymer - fig. 24-50 PIR

.3 Type P-22 (cellular glass):

- .1 cellular glass to ASTM C552,
- .2 nominal pipe size: NPS 1-1/2 to NPS 24,
- .3 density: nominal 120 kg/m³ (7.5 lb/ft³),
- .4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .5 service temperature: -73°C to +121°C (-100°F to 250°F),
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84.

Standard of Acceptance

- ° Owens Corning - fig. Foamglas

.4 Type P-23 (calcium silicate):

- .1 calcium silicate to ASTM C533 Type I, with integral corrosion inhibitor to reduce under insulation corrosion, asbestos-free,
- .2 nominal pipe size: NPS 1-1/2 to NPS 24,
- .3 density: nominal 232 kg/m³ (14.5 lb/cu ft),
- .4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),
- .5 service temperature: 20 to 649°C (70 to 1200°F),
- .6 thermal performance: 0.058 W/m/C @ 149°C (0.40 btu/hr/in/sq ft/F @ 300°F).

Standard of Acceptance

- ° Johns Manville - fig. Thermo-12 Gold

3 EXECUTION

3.1 General

- .1 Where repairs are made to existing insulated piping due to connections of new piping work, the insulation thickness for the existing piping is permitted to match the existing insulation nominal thickness, provided the extent of new insulation does not exceed a length of 1000 mm (39 in).

3.2 Applicable Systems – Hot piping

- .1 Insulate Hot piping systems including pipe, valves, fittings, and pipeline accessories in accordance with the Tables at the end of this Specification section.
 - .1 Table 1A for all piping except engine combustion gas exhaust piping,
 - .2 Table 1B for engine combustion gas exhaust piping.
- .2 Insulate condensate piping in accordance with the same criteria as its associated steam system.
- .3 Insulate piping for safety valves or safety relief valves that is located;
 - .1 less than 2.4 m (8 ft) above a floor or work surface, or
 - .2 within 1 m (39 in) horizontally of, and less than 2.4 m (8 ft) above, an elevated work surface.

3.3 Applicable Systems - Cold and Dual Temperature Piping

- .1 Insulate Cold and Dual temperature piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Table 2 at the end of this Specification section.
- .2 Insulate the following drainage services or equipment:
 - .1 storm water drainage systems in the following locations:
 - (a) roof drain bodies,
 - (b) rainwater leaders (storm water piping) from roof drain bodies to the floor level below the drain body,
 - (c) rainwater leaders in or above data and telecommunication rooms,
 - (d) rainwater leaders in or immediately above wet areas.
 - .2 sanitary piping in the following locations:
 - (a) horizontal sanitary drainage piping NPS 3 and larger in ceiling spaces,
 - (b) sanitary drainage piping in or above wet areas,
 - (c) sanitary drainage piping in or above data and telecommunication rooms,
 - (d) exposed sanitary drainage piping in service tunnels,
 - (e) exposed sanitary drainage piping serving spaces located in a parking garage,
 - (f) and where shown on drawings.

3.4 Insulating Hot Piping

- .1 Secure insulation for domestic hot water piping, domestic hot water recirculation piping, non-potable hot water piping and non-potable hot water recirculation piping in accordance with the requirements for insulating Cold and Dual Temperature piping.
- .2 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.
- .3 Secure insulation with integral ASJ or FSK jackets by stapling the lap flap on 75 mm (3 in) centers or by use of self-sealing lap adhesive strip.

- .4 Secure insulation that does not have an integral ASJ or FSK jacket by use of stainless steel wire at not less than 300 mm (12 in) centers, or by a continuous wire helix on the same center spacing.
- .5 For type P-2 and P-4 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);
 - .1 provide two layers of approximately equal thickness such that the total thickness is as specified,
 - .2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and
 - .3 secure the first layer of insulation with stainless steel wire on 300 mm (12 in.) centers, and secure the second layer with band straps on 300 mm (12 in) centers.
- .6 Secure butt joints with vapour barrier tape or insulation butt strips.
- .7 For piping service temperatures greater than 121°C (250°F);
 - .1 apply insulation finishing cement at all exposed edges of insulation where the insulation is interrupted by valves, connections to other equipment, and piping supports and anchors.

3.5 Insulating Cold and Dual Temperature Piping

- .1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.
- .2 Secure insulation with integral ASJ and FSK jackets by;
 - .1 sealing all lap flaps and butt strips with vapour barrier adhesive, or
 - .2 securing insulation with staples on 75 mm (3 in) centers and covering longitudinal seams with vapour barrier tape, or
 - .3 use of integral self-sealing vapour barrier jacket with lap flaps and butt strips.
- .3 Except for type P-6 insulation, secure insulation that does not have an integral ASJ or FSK jacket by:
 - .1 use of 12 mm (1/2 in.) wide reinforced filament tape on approximately 150 mm (6 in.) centers for piping NPS 4 and smaller, and use stainless steel banding on 225 mm (9 in.) centers for piping NPS 6 and larger, and
 - (a) apply an all-service-jacket with 100% coverage of adhesive suitable for the insulation material, with longitudinal and butt seams having a 50 mm (2 in) overlap, and seal the laps with vapour barrier adhesive/ coating, or
 - (b) apply a heavy brush coat of vapour barrier coating at the rate of 1.2 L/m² (2.5 Imp.gallon per 100 ft²), embed a layer of reinforcing membrane, and then applying a second heavy brush coat of vapour barrier coating at the rate of 1.0 L/m² (2.1 Imp.gallon per 100 ft²).
- .4 For type P-2 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);
 - .1 provide two layers of approximately equal thickness such that the total thickness is as specified,
 - .2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and
 - .3 secure the first layer of insulation with stainless steel wire on 300 mm (12 in.) centers, and secure the second layer with stainless steel banding on 225 mm (9 in) centers.
- .5 Secure type P-6 insulation with field-applied adhesive or self-adhesive longitudinal edge seams, and apply vapour barrier adhesive/sealant to butt joints.
- .6 Secure butt joints with vapour barrier tape, unless otherwise sealed using vapour barrier adhesives and coatings.

- .7 For straight pipe runs greater than 15 m (50 ft) and at every 15 m (50 ft) length thereafter, provide an insulation expansion joint consisting of 50 mm (2 in) wide flexible glass-fibre insulation for full depth of pipe insulation. Seal adjacent pipe insulation ends with vapour barrier coating.
- .8 Where pipe anchors are attached to chilled water piping;
 - .1 cover exposed ends of cut insulation with reinforced vapour barrier coating, with the fabric and coating overlapping by at least 50 mm (2 in.) onto the pipe anchor,
 - .2 insulate the pipe anchor with type P- 6 insulation (in round or equivalent sheet form) to a distance equal to 10 times the largest outside dimension of the anchor structure element, but not less than 150 mm (6 in) beyond pipe insulation outer surface,

3.6 Insulation of Fittings, Flanges, and Couplings – Hot, Cold and Dual Temperature Piping

- .1 Insulate fittings including elbows and tees, other than flanges and grooved-couplings:
 - .1 NPS 1½ and smaller:
 - (a) miter cut insulation to create tight fit,
 - (b) where PVC covers are used, trim backside of insulation on elbows to suit cover but do not reduce total thickness less than that of adjacent pipe insulation.
 - .2 NPS 2 and larger:
 - (a) use matching preformed insulation inserts, or fabricate tightly-fitting mitered insulation segments made from the same material as pipe insulation,
 - (b) number of mitered segments to be sufficient to maintain thickness of insulation around throat of elbow or tee,
- .2 Insulate flanges and grooved-joint couplings:
 - .1 insulate with preformed inserts or build-up insulation with same material as on adjacent pipe:
 - (a) butt pipe insulation to each side of flange or grooved-joint coupling,
 - (b) build up rigid insulation blocking on each side of flange or grooved-joint coupling, with a width dimension same as pipe insulation thickness,
 - (c) apply insulation layer over the top of the flange or coupling to a thickness equal to pipe insulation thickness.
- .3 Where type P-5 or P-7 insulation is used;
 - .1 insulate as described above except use factory made insulation inserts, or fabricate inserts to suit the pipe fitting, flange or coupling.
- .4 Where type P-6 insulation is used;
 - .1 insulation as described above except adhere insulation to fitting, flange, or coupling with 100% coverage of adhesive,
 - .2 do not adhere insulation across bolted connections - insulate on each side of connection and add additional insulation layer across connection and fix in place with bands and seal joints.
- .5 Secure insulation with stainless steel wire (Hot piping), or vapour barrier tape (all piping), prior to application of coatings and finishes.

3.7 Insulation of Pipeline Accessories – Hot, Cold and Dual Temperature Piping

- .1 Insulate pipeline accessories depending on service temperature:
 - .1 valves,
 - .2 strainers,

- .3 pressure reducing valves,
- .4 control valves,
- .5 meters,
- .6 steam separators.
- .2 Insulate pipeline accessories for Hot piping systems with service temperatures greater than 93°C (200°F) as follows:
 - .1 insulated with type P-8 removable/reusable fitted insulation covers, designed to allow free movement of valve actuator,
 - .2 insulation is not required at this service temperature range for drain valves, blowoff/blowdown valves, and drip caps or plugs.
- .3 Insulate pipeline accessories for Hot piping systems with service temperature greater than 60°C (140°F) and up to 93°C (200°F) or less, as follows:
 - .1 insulated with:
 - (a) type P-8 removable/reusable fitted insulation covers designed to allow free movement of valve actuator, or
 - (b) insulated with fitted pipe insulation segments, or oversized sections of insulation arranged to permit its removal and reinstallation, or
 - (c) tightly placed flexible insulation and covered with PVC fitting covers.
 - .2 insulation is not required at this service temperature range for drain valves, drain caps/plugs, and for pipeline accessories NPS 1 and smaller.
- .4 Insulation of pipeline accessories is not required for Hot piping with service temperatures less than 60°C (104°F).
- .5 Insulate pipeline accessories for chilled water, liquid refrigerant, and dual temperature heating/cooling systems as follows:
 - .1 detachable insulated box type with embossed aluminum or stainless steel jacket, with vapor barrier tape applied to seams when installed, and lined with one layer of 25 mm (1 in) P6 elastomeric blanket with no voids at corners or joints,
 - .2 alternatively, for accessories NPS 8 and larger, install one layer of 25 mm (1 in) type P-6 elastomeric blanket insulation adhered to pipeline accessories with 100% adhesive coverage, and all joints sealed with manufacturers sealant, including the joint between P-6 insulation and adjacent piping insulation,
 - (a) at locations requiring access, extend insulation to create a collar around bolted connection, and install a compression fit piece of insulation to cover equipment.
 - .3 alternatively, for accessories NPS 4 and smaller, insulate with fitted pipe insulation or mitered blocks with all joints sealed with two coats of vapour barrier coating complete with reinforcing membrane.
- .6 Insulate accessories for all other Cold and Dual Temperature Piping systems as follows:
 - .1 insulate with flexible blanket insulation, fitted pipe insulation or mitered block of same material and thickness of adjacent piping and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.
- .7 At locations requiring access including valve handles, valve actuators, drain valves, etc. cut-back insulation and seal exposed edges.

3.8 Additional Requirements for Insulation of Engine Combustion Gas Exhaust Piping

- .1 In addition to the general requirements for Hot piping insulation installation specified herein, insulate field-fabricated engine combustion gas exhaust piping systems as follows:
 - .1 where the 1st insulation layer is ceramic fibre, install the 1st layer of insulation with at least 50 mm (2 in) longitudinal overlap;
 - (a) do not stretch-out the insulation.
 - (b) secure with stainless steel wire in a double helix at approximately 225 mm (9 in.) on centers and at an incline of approximately 45°,
 - .2 where the 2nd insulation layer is mineral wool, install the 2nd layer of insulation by compressing slightly the 1st layer and secure the 2nd layer insulation with stainless steel bands at not more than 225 mm (9 in) spacing,
 - .3 where calcium silicate insulation is used, do not use adhesive to attach the insulation to the equipment,
 - .4 provide type P-23 (calcium silicate) high-density insulation inserts at hanger support locations where clevis hanger or trapeze hangers are used.
 - .5 for straight piping runs greater than 15 m and at every 15 m length thereafter;
 - (a) provide an insulation expansion joint consisting of 50 mm (2 in) wide type P-10 insulation for full depth of both insulation layers,
 - (b) where insulation expansion joint is concealed, secure with a stainless steel cover jacket that extends at least 50 mm (2 in) on each side of the insulation expansion joint.

3.9 Additional Requirements for Insulation of Drainage Systems - Additional Requirements

- .1 In addition to the general requirements for Cold and Dual Temperature piping insulation specified herein, insulate the underside of roof drain hoppers with flexible blanket insulation of same type as pipe insulation, and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.

3.10 Additional Requirements for Insulation of MRI Quench Vent Piping

- .1 In addition to the general requirements for Cold and Dual Temperature piping insulation specified herein, insulate MRI quench vent piping in accordance with the following supplemental requirements:
 - .1 insulate piping located inside the building,
 - .2 insulate piping located outdoors as follows:
 - (a) insulate vertical vent piping to a height of 2.8 m (8 ft) above the roof or ground level,
 - (b) horizontal vent piping and discharge are not required to be insulated.
 - .3 provide two layers of insulation of applicable thickness as specified in the article Schedules at the end of this Section,
 - .4 stagger insulation joints between the layers so that no joint in one layer aligns with a joint on the other layer,
 - .5 provide vapour barrier sealing on the first (inner) layer using reinforced vapour barrier coating,
 - .6 cover the second insulation layer with jacket material as specified in the article Schedules at the end of this section.
 - .7 install insulation over expansion joints to allow removal to permit inspection of the expansion joint,

3.11 Insulation Protection at Pipe Supports

- .1 Provide insulation protection at pipe supports in accordance with Table 3 at the end of this section, based on pipe size and service process temperature.
- .2 Installation of pipe insulation saddle protection for Hot piping:
 - .1 pipe saddles provided under Specification section 20 05 29,
 - .2 insulate the interior void spaces of pipe saddles, using the same material as adjacent pipe insulation,
 - .3 butt insulation up to sides and end of pipe saddle, and leave bottom surface of saddle exposed for direct contact with pipe support.
- .3 Installation of pipe insulation shield protection for hot and cold piping:
 - .1 pipe insulation shields are provided under Specification section 20 05 29,
 - .2 provide high-density insulation inserts at the pipe support location;
 - (a) insert length: at least 50 mm (2 in) longer than the shield length to allow application of vapour barrier sealant or tape, but not less than the following:

Pipe Size NPS	Insert Length mm (in)
1 ½ to 2	250 (10)
2 ½ - 6	300 (12)
8 - 10	400 (16)
≥ 12	560 (22)

- (b) arc width: one-half of the pipe diameter for type P-21 insets, and one-third of the pipe diameter for types P-22 and P-23 insets,
 - .3 fabricate the high-density inserts so their thickness is the same as the adjacent installed pipe-run insulation, with finished surface thickness within +3 mm/-0 mm (+1/8 in / -0 in) of adjacent pipe insulation thickness,
 - .4 for cold water piping, apply insulation cover and vapour barrier sealant to fully cover and seal the high-density insert, and to overlap the adjacent pipe-run insulation by at least 50 mm (2 in) on all edges,
 - .5 install the insulation shield between the finished insulation and the support pipe; the pipe support is sized for the outside dimension of pipe and insulation.
- .4 Insulation of type "T" slide supports for Cold and Dual Temperature piping
 - .1 insulate the exposed surfaces of the pipe slide with 12 mm (1/2 in.) thick type P-6 insulation, neatly cut and adhered to the slide steel surfaces,
 - .2 apply vapour barrier sealant dam at the juncture with the pipe-run insulation, and at the termination of the insulation.
- .5 Insulation of type "H" slide supports for Cold and Dual Temperature piping:
 - .1 provide sheet metal caps to cover the open ends of the slide and secure caps with stainless steel banding, and fill the two voids in the H-slide support with polyurethane expansion foam insulation,
 - .2 apply 12 mm (1/2 in) thick type P-3 insulation to the exterior surfaces of the H-slide support,

- .3 apply vapour barrier sealant dam at the juncture with the pipe-run insulation, and at the termination of the insulation.

3.12 Insulation at Floor and Wall Openings

- .1 Extend pipe insulation at full required thickness through floor and wall openings for Hot, Cold and Dual Temperature piping. Vapour barrier jackets for Cold and Dual Temperature piping are to extend unbroken through the wall or floor penetration. Finish coverings for Hot piping with service temperatures not exceeding 93°C (200°F) may terminate on each side of the opening.
- .2 Reduction in insulation thickness through floor or wall openings is not permitted except by prior approval of Consultant on specific exceptional case basis;
 - .1 exception: Hot piping with service temperature not exceeding 93°C (200°F) may be reduced by one-half the required thickness stated in Table 1A through wall and floor penetrations, but such thickness reduction shall not extend more than 25 mm (1 in.) on each side of the opening.
- .3 For penetrations through fire rated separations, provide finishes in accordance with fire stopping manufacturer's listing requirements.
- .4 For outdoor piping passing through exterior walls or roof, terminate mastic lagging at outside face of sleeve and provide storm flashing to protect insulation, caulked to lagging and to building structure.

3.13 Sealing of Insulation – Hot Piping

- .1 Seal hot piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet areas):
 - .1 except where a separate protective finishing jacket is used, apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,
 - .2 do not tape lap joints except as required to secure the insulation,
 - .3 where a separate protective finishing jacket is provided, no additional sealing of the insulation is required.
- .3 Indoor installations – wet areas:
 - .1 regardless of how insulation is secured, apply vapour barrier tape to:
 - (a) all longitudinal lap seams and butt edges,
 - (b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.
- .4 Outdoor installation:
 - .1 apply two coats of breather mastic complete with reinforcing membrane to all lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket.

3.14 Sealing of Insulation – Cold and Dual Temperature Piping

- .1 Seal Cold and Dual Temperature piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 Indoor installation (except wet locations):
 - .1 except for chilled water and Dual Temperature piping, tightly seal insulation ASJ jacket longitudinal seams and butt joints;
 - (a) using factory or field fabricated lap seams and butt joint strips with adhesive, or
 - (b) by applying colour matched vapour barrier tape to all edges, overlapping joint by minimum 50 mm (2 in) each side,

- (c) where factory lap seams are damaged, apply colour matched vapor barrier tape along the damaged edges,
- .2 for chilled water and dual temperature piping insulation with ASJ jackets, tightly seal longitudinal seams and butt joints;
 - (a) with two coats of vapor barrier coating complete with reinforcing membrane,
 - (b) for pipe size NPS 6 and smaller, colour matched vapour barrier tape is permitted to be used depending on location of piping in accordance with the following table.

Insulation Joint Sealing – Pipes NPS 6 and Smaller		
Piping Location	Vapour Barrier Tape	Vapour Barrier Coating with Membrane
Mechanical Service Rooms	No	Required
Vertical Service Spaces (shafts)	No	Required
Tunnels and trenches	No	Required
Unconditioned spaces	No	Required
Conditioned Spaces	Permitted [Note 1]	Permitted
Ceiling spaces over Conditioned Spaces	Permitted [Note 1]	Permitted
IT rooms	No	Required

Notes:

[1] Pipe size NPS 6 and smaller only.

- (a) overlap insulation edges and butt joint by minimum 50 mm (2 in) each side,
- (b) seal the butt end of the insulation with vapour barrier coating, overlapping onto the piping, at every fourth length of piping, but not to exceed 4 m (13 ft) in pipe run length.
- .3 cover mechanical fastener penetrations including staples with colour matched vapour barrier tape, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.
- .4 seal insulation on pipe elbows, tees, flanges, joints, couplings, and other fittings;
 - (a) with two coats of vapor barrier coating complete with reinforcing membrane,
 - (b) for pipe sizes NPS 6 and smaller, colour matched vapour barrier tape may be used in locations as described in the above table for piping.
- .3 Indoor installations – wet areas:
 - .1 in wet areas, tightly seal piping in accordance with the requirements for outdoor installation except use vapour barrier coatings.
- .4 Outdoor installation:
 - .1 tightly seal insulation with two coats of vapour barrier mastic complete with reinforcing membrane;
 - (a) at all lap edges and butt joints,
 - (b) 100% coverage of insulation of pipe elbows, tees, flanges, joints, couplings, and other fittings,
 - (c) to cover mechanical fastener penetrations including staples,
 - (d) in all cases overlapping the joint, fitting or fastener by a minimum 50 mm (2 in) each side.
- .5 In all locations;
 - .1 seal insulation that does not have a factory applied ASJ jacket with 100% coverage of two coats of vapor barrier coating/mastic complete with reinforcing membrane,

- .2 seal high-density inserts for pipe supports with two coats of vapour barrier coating/mastic complete with reinforcing membrane, overlapping adjacent insulation a minimum of 50 mm (2 in).

3.15 Insulation Finish Covering

- .1 Provide insulation finish coverings selected in accordance with Table 4 at the end of this Specification section and installed in accordance with Specification section 20 07 11 and/except as specified herein.
- .2 Self-adhesive weather barrier (SAWB) coverings;
 - .1 apply SAWB in accordance with manufacturer's instructions,
 - .2 do not place an overlap within one-eighth pipe diameter on each side of a horizontal pipe top centerline,
 - .3 for vertical piping, overlap higher layers over lower layers with an overlap not less than 100 mm (4 in).

3.16 Mechanical Damage Protection - Indoors

- .1 Protect exposed pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) stainless steel jacket approximately 200 mm (8 in) high, secured with rivets and mechanically fastened to the floor with countersunk stainless steel screws.
- .2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.
- .3 For clarity, where piping systems use finish covering in accordance with Table 4 of this Specification section, this mechanical damage protection cover is in addition to the specified pipe finish cover.

3.17 Painted Piping

- .1 Prime and top-coat painting is provided under Division 09
- .2 Finish piping with canvas or fiberglass lagging for the following piping systems that are to be painted:
 - .1 piping inside of boiler and refrigeration rooms,
 - .2 piping inside of other mechanical service rooms,
 - .3 exposed piping in public areas including;

3.18 Fire Rated Pipe Insulation

- .1 Provide two (2) hour rating of type P-9 insulation on piping where shown.
- .2 Install insulation in accordance with fire-rated insulation manufacturer's listing requirements. Coordinate with the applicable piping contractor as to any pipe support requirements of the fire-rated insulation installation instructions.

3.19 Standard Details

- .1 Refer to Specification section 20 05 29 for illustration of coordination of insulation with pipe supports, unless otherwise shown on drawings.

3.20 Insulating, Support Inserts and Finishes Tables

- .1 The insulating and finishing tables follow:
 - .1 Table 1A - Hot piping Systems, Insulation Type and Thickness (excluding engine combustion gas exhaust piping)
 - .2 Table 1B - Hot Equipment Insulation Type, Thickness, and Coverings For Engine Combustion Gas Exhaust Piping

- .3 Table 2 - Cold and Dual Temperature Piping Systems, Insulation Type and Thickness
- .4 Table 3 - Insulation Hanger Protection
- .5 Table 4 - Piping Insulation Protective Finishes.

Table 1A:
Hot Piping Insulation Type and Thickness
(excluding engine combustion gas exhaust piping)

System	Fluid Nominal Temp. °C (F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Steam and Condensate > 860 kPa (125 psi)	177 to 315°C (351 to 600°F)	P-3	115 (4.5) [Note 3]	125 (5) [Note 3]	125 (5)	125 (5)	125 (5)
		P-4	---	---	---	---	125 (5) [Note 1, 2]
		P-7	200 (8) [Note 3]	200 (8) [Note 3]	200 (8)	175 (7)	175 (7)
Steam and Condensate > 100 kPa (15 psi) and ≤ 860 kPa (125 psi) Boiler Feed Water	122 to 176 (251 to 350)	P-1 P-3	80 (3) [Note 3]	100 (4) [Note 3]	115 (4.5)	115 (4.5)	115 (4.5)
		P-2 P-4	---	---	---	---	150 (6) [Note 1, 2]
		P-7	125 (5) [Note 3]	175 (7) [Note 3]	175 (7)	175 (7)	150 (6)
Safety Relief Piping	122 to 176 (251 to 350)	P-1 P-3	40 (1½)	40 (1½)	40 (1½)	40 (1½)	40 (1½)
Steam and Condensate ≤ 100 kPa (15 psi) High temperature hot water heating	94 to 121 (201 to 250)	P-1 P-3	65 (2.5) [Note 3]	65 (2.5) [Note 3]	80 (3)	80 (3)	90 (3½)
		P-2 P-4	---	---	---	---	100 (4) [Note 1, 2]
		P-7	125 (5) [Note 3]	100 (4) [Note 3]	125 (5)	125 (5)	125 (5)
Hot Water Heating Glycol Heating Pumped Condensate	61 to 93 (141 to 200)	P-1 P-3	40 (1½) [Note 3]	40 (1½) [Note 3]	50 (2)	50 (2)	50 (2)
		P-2 P-4	---	---	---	---	65 (2½) [Note 1, 2]
		P-7	65 (2½) [Note 3]	65 (2½) [Note 3]	65 (2½)	65 (2½)	65 (2½)
Hot Water Heating (Buried)	61 to 93 (141 to 200)	P-5	50 (2) [Note 3]	50 (2) [Note 3]	65 (2.5)	65 (2.5)	65 (2.5)

...continued on next page

Table 1A: (Continued)
Hot Piping Insulation Type and Thickness
(excluding engine combustion gas exhaust piping)

System	Fluid Nominal Temp. °C (°F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Pure Water (with heat sanitization)	25 to 93 (77 to 200)	P-1 P-3	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
Low Temperature Hot Water Heating Low Temperature Glycol Heating	41 to 60 (105 to 140)	P-1 P-3	25 (1)	25 (1)	40 (1½)	40 (1½)	40 (1½)
Domestic Hot Water Domestic Hot Water Recirculation Not-Potable Hot Water Non-Portable Hot Water Recirculation	41 to 60 (105 to 140)	P-1 P-3	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	40 (1 ½)
Condenser Water (outdoors)	16.5 to 40 (61 to 104)	P-3 P-4 P-5	40 (1½)	40 (1½)	40 (1½)	40 (1½)	40 (1½)
Fire protection Sprinkler piping and valves, Fire protection Standpipe piping and valves [Note 4]	4 to 40 (50 to 104)	P-1 P-3	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	40 (1 ½)

Notes:

[1] For NPS 14 and larger.

[2] Install in two layers of insulation to make up total thickness.

[3] For piping NPS 1-1/4 and smaller located in partitions within conditioned spaces, insulation thickness may be reduced by up to 25 mm, but final thickness shall not be less than 25 mm.

[4] For heat-traced fire protection piping only, including drum drip assemblies on dry systems.

Table 1B:
Hot Equipment Insulation Type, Thickness, and Coverings
For Engine Combustion Gas Exhaust Piping

Equipment Description	Exhaust Gas Service Temperature °C (°F)	1 st Layer Type x Thickness mm (in)	2 nd Layer Type x Thickness mm (in)	Protective Finishing Covering, Exposed Piping [Note 1]
Natural Gas Engine combustion gas exhaust piping	≤ 700 (≤ 1292)	P-10 50 (2)	P-3 90 (3.5)	Fabric
		P-10 50 (2)	P-3 150 (6) [Note 2]	Stainless Steel
Diesel Engine combustion gas exhaust piping	≤ 540 (≤ 1000)	P-10 25 (1)	P-3 50 (2)	Fabric
		P-10 50 (2)	P-3 90 (3.5)	Stainless Steel
		P-7 40 (1.5)	P-7 50 (2)	Fabric
		P-7 75 (3)	P-7 90 (3.5)	Stainless Steel

Notes:

[1] For exposed piping located indoors. See table 4 for other locations.

[2] Made up of two equal thickness layers with a total thickness of the indicated value.

Table 2:
Cold and Dual Temperature Piping Insulation Type and Thickness

System	Fluid Nominal Temp. °C (°F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Dual Temperature Heating/Cooling	4 to 93 (39 to 200)	P-1 P-3	40 (1½)	40 (1½)	50 (2)	50 (2)	50 (2)
		P-2	---	---	---	---	65 (2½) [Note 1, 2]
Domestic Cold Water Non-potable Water	4 to 16 (39 to 61)	P-1 P-3	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	50 (2)
Storm and Sanitary Drainage	4 to 16 (39 to 61)	P-1	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
		P-6	15 (1/2)	20 (3/4)	25 (1) [Note 3]	---	---
Equipment Drains	4 to 16 (39 to 61)	P-6	15 (1/2)	20 (3/4)	25 (1) [Note 3]	---	---
Chilled Water, Glycol Heat Recovery	4 to 16 (39 to 61)	P-1 P-3 P-5	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	50 (2)
Chilled Water (Outdoors)	4 to 16 (39 to 61)	P-3	50 (2)	50 (2)	50 (2)	75 (3)	75 (3)
Chilled Water (Buried)	4 to 16 (39 to 61)	P-5	25 (1)	25 (1)	40 (1 ½)	40 (1 ½)	40 (1 ½)
Refrigerant Suction	< 4 (< 39)	P-6	25 (1)	25 (1)	25 (1) [Note 3]	---	---
MRI Quench Vent	-268 (-450)	P-3 (inner layer)	---	---	---	25 (1)	25 (1)
		P-6 (outer layer)	---	---	---	25 (1)	25 (1)

Notes:

[1] For NPS 14 and larger.

[2] Install in two layers of insulation to make up total thickness.

[3] Do not use on pipe size NPS 2-1/2 to 3.

Table 3:
Insulation Hanger Protection

Service Temperature °C (F)	Pipe Size NPS	Pipe Saddle	Insulation Shield	High-Density Insert
≥ 93 to 205 (≥ 200 - 400)	≥ 1-1/2	Yes	---	---
	≤ 1-1/4	---	Yes	P-23
61 to 93 (141 to 200)	> 6	Yes	---	---
	≥ 1-1/2 and ≤ 6	---	Yes	P-22, P-23
	≤ 1-1/4	---	Yes	---
26 to 60 (80 to 140)	≥ 1-1/2	---	Yes	P-22, P-23
	≤ 1-1/4	---	Yes	---
Cold & Dual Temp	≥ 1-1/2	---	Yes	P-22
	≤ 1-1/4	---	Yes	P-21, P-22
Fire protection piping	≥ 1-1/2	---	Yes	P-22
	≤ 1-1/4	---	Yes	P-21, P-22
MRI Quench Piping	All	---	Yes	P-22

Table 4:
Piping Insulation Finish Coverings

Location	Exposed/ Concealed	Piping System	Finish Covering
Indoors	Concealed	MRI quench vent piping	SAWB
		Engine combustion gas exhaust piping	Fabric if no FSK jacket
		Piping with insulation types P-4, P-5, P-7, P-10	SAWB or PVC
		All other piping	None (factory jacket only)
	Exposed	Steam 345 kPa (50 psig) and over	Fabric
		Wet Areas	PVC
		Piping (insulation) which will be painted	Fabric
		Fire Protection Piping	PVC (red in colour)
		Engine combustion gas exhaust piping	Refer to Table 1B
		All other piping	PVC Fabric Metal
Outdoors	Any	Engine combustion gas exhaust piping	Stainless Steel
		MRI quench vent piping	Stainless Steel
		All other piping	Stainless Steel

End of Section

CLOSEOUT REQUIREMENTS FOR MECHANICAL WORK

20 77 19.20

1 GENERAL

1.1 Scope

- .1 Provide documentation deliverables at completion of the Work for the following milestone events:
 - .1 Occupancy permit (where applicable) (Form OP1M),
 - .2 Substantial Performance of the Work (Form SP1M),
 - .3 Ready for take-over by Owner (Form RFT1M),
 - .4 Total Performance of the Work (Form TP1M).

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Occupancy permit** – means either: (i) a permit issued by a regulatory authority to allow the Owner to occupy the building subject to the building permit, or (ii) a building permit close-out procedure where documentation must be submitted to the building authority for that purpose.

1.3 General

- .1 The prerequisites and submittal of supporting documentation for the aforementioned milestone events may be combined as a single submission at one point in time for the following combination of events:
 - .1 Occupancy Permit, and Substantial Performance.
- .2 Where a prerequisite is listed in more than one milestone event, it shall be included in the earliest-occurring milestone event unless expressly specified otherwise.

1.4 Occupancy Permit

- .1 Submit the reviewed final record of the Testing of Integrated Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit, where such a report is required.
- .2 Complete the Occupancy Permit Checklist and submit with required documentation to support the Owner's application for occupancy.

1.5 Substantial Performance

- .1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
- .2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .3 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.6 Ready-for-Takeover by Owner

- .1 The basic prerequisites to attaining Ready-for-Takeover of the Work are described in the General Conditions and Supplementary General Conditions of the Contract.

- .2 Complete the Ready-for-Takeover Checklist and submit with required documentation when applying for Ready-For Takeover of the Work.

1.7 Total Performance

- .1 Complete the Total Performance Checklist and submit with required documentation when applying for Total Performance of the Work.

Form OP1M: OCCUPANCY PERMIT CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Building department inspection reports.
- ☐ AHJ pressure piping inspection reports (if applicable).
- ☐ AHJ fuel system inspection reports (if applicable).
- ☐ AHJ electrical systems inspection reports.
- ☐ Sprinkler installation certification report to NFPA 13.
- ☐ Standpipe installation certification report to NFPA 14.
- ☐ Fire pump installation and test certificate to NFPA 20.
- ☐ Integrated Fire Protection and Life Safety test report to ULC-S1001.
- ☐ Medical gas inspection report and certificate.
- ☐ Air and Water Balancing reports (Interim) for ventilation and heating.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

Form SP1M: SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Systems have been started-up, tested, and demonstrated to Owner or Consultant.
- ☐ First submission TAB reports have been submitted to Consultant.
- ☐ Acoustic survey report submitted to Consultant (if specified).
- ☐ Vibration survey report submitted to Consultant (if specified).
- ☐ Controls / BMS operation report submitted to Consultant (if specified).
- ☐ Equipment, pipeline, and valve identification completed
- ☐ Spare parts and replacement parts turned over to Owner, transmittal attached.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

Form RFT1M: READY-FOR-TAKEOVER APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Substantial Performance has been certified or verified.
- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Final cleaning and waste removal completed.
- ☐ Delivery to Owner of Operating and Maintenance documents for systems being taken-over by Owner.
- ☐ Submit copies of up-to-date as-built drawings.
- ☐ Final start-up, testing and balancing reports completed and submitted to Owner, including any items requiring corrections identified by Consultant.
- ☐ The portions of the building being turned over to the Owner can be secured by Owner.
- ☐ Demonstration and training are completed, or Contractor and Owner has agreed to a schedule to provide such training to be completed within one month after the date of Ready-for-Takeover.
- ☐ All commissioning activities except for those activities that are identified or otherwise agreed by the Owner to be deferred commission activities which may be completed after Ready-for-Takeover of the Work.
- ☐ Integrated systems testing of fire protection and life safety systems.
- ☐ All warranties have been submitted to the Owner.
- ☐ A comprehensive list of items to be completed or corrected is provided to Owner and Consultant and included in the application for Ready-for-Takeover, and includes a schedule of when such work will be completed.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

Form TP1M: TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ All final Operating and Maintenance documents have been delivered to Owner.
- ☐ All final up-to-date as-built drawings have been delivered to Owner.
- ☐ Any follow-up testing and balancing reports, including alternate season testing reports, have been submitted to Owner.
- ☐ All demonstration and training are completed.
- ☐ All commissioning activities are completed, including deferred alternate season commissioning activities.
- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ All inspections and tests required to be performed by Contractor or manufacturer's prior to expiry of the warranty period have been completed, and documentation for those inspections and tests are included in this application.

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

End of Section

COMMON WORK RESULTS FOR PLUMBING PIPING

22 05 01

1 GENERAL

1.1 Scope

- .1 Provide piping systems for plumbing, drain and vent systems for:
 - .1 potable (domestic) water systems,
 - .2 non-potable water piping systems,
 - .3 drainage system including:
 - (a) sanitary drainage and vent systems,
 - (b) storm water drainage systems,
 - (c) pumped sewage systems.
 - .4 other plumbing systems including:
 - (a) irrigation systems,
 - (b) grey water systems,
 - (c) specific duty piping systems otherwise specified in Division 22.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 73.13 Mechanical Services for General Facility Equipment
 - .2 22 05 19 Utility Water Meters

1.3 Applicable Codes and Standards

- .1 Legislation:
 - .1 Ontario Building Code
 - .2 Municipal bylaws regarding potable water, water services, and sewage systems.
- .2 Installation standards and codes:
 - .1 AWWA C651 Disinfecting Water Mains.
- .3 Product standards:
 - .1 CSA B272 Pre-Fabricated Self Sealing Roof Vent Flashings

1.4 Qualified Tradesmen

- .1 Work to be performed by qualified and recognized firm with an established reputation in this field, using tradesmen holding certificates of competency.

2 PRODUCTS

2.1 Flashings

- .1 Through-roof penetration flashing, and other waterproofed areas:
 - .1 manufactured from composite material in accordance with CSA B272,

- .2 minimum dimensions of 500 mm x 500 mm (20 in x 20 in),
- .3 with sleeve extending at least 150 mm (6 in) above roof.

2.2 Dielectric Unions

- .1 Construction:
 - .1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.
 - .2 FNPT x Copper sweat connection.
 - .3 Pressure rating; ASME Class 3000 at 121°C (250°F)

Standard of Acceptance

- ° Hart Industrial Unions - fig. D-3136 or Polymer Composite Coating

2.3 Dielectric Flanges

- .1 Construction:
 - .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.
 - .2 Flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece from contact with the flange.
 - .3 Minimum MCPR:
 - (a) Class 150: 1400 kPa (200 psi) at 121°C (250°F)
 - (b) Class 300: 2800 kPa (400 psi) at 121°C (250°F)

Standard of Acceptance

- ° CTS Flange Canada - fig. BF / WBG

3 INSTALLATION

3.1 Piping

- .1 Piping system routing is shown diagrammatically. Locate mains, risers and runouts concealed behind furrings or above ceilings except in mechanical equipment rooms and access spaces where piping is to be exposed.
- .2 Determine areas without ceilings from Architectural Drawings and Room Finish Schedules, and in these areas keep piping as high as possible.
- .3 Anchor, guide and support vertical and horizontal runs of piping to resist dead load and absorb thrust.

3.2 Domestic Cold Water System Distribution

- .1 Extend existing domestic cold water system with
 - .1 distribution pipe and fittings,
 - .2 valves,
 - .3 premises backflow isolation,
 - .4 zone or equipment backflow protection.

3.3 Domestic Hot Water System Distribution

- .1 Extend existing domestic hot water system with

- .1 distribution pipe and fittings
- .2 valves
- .3 zone or equipment backflow protection.
- .2 Provide cold water connections to hot water tank, with shut-off and check valve on supply and valved drain at bottom of tank. Drill check valve disc with 1.6 mm (1/16 in) hole in its centre.
- .3 Provide valved connections from hot water supply system to fixtures and other equipment requiring hot water.

3.4 Domestic Hot Water Recirculation System

- .1 Extend existing domestic hot water recirculation system with
 - .1 distribution pipe and fittings
 - .2 valves
 - .3 pumps
- .2 Connect ends of hot water risers to recirculation mains and extend to recirculation pump.
- .3 Provide minimum flow balancing valves at each connection between the domestic hot water loop and the hot water recirculation loop.

3.5 Dissimilar Metals Galvanic Isolation

- .1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon (plain and galvanized) steel material.
 - .1 For clarity, dielectric unions or flanges are not required when connecting copper to T304 or T316 stainless steel pipe or tubing.
- .2 Refer to specification section 23 05 01 for exemptions when connecting domestic water copper piping or stainless steel piping to HVAC piping systems.

3.6 Drainage

- .1 Provide roof drains and storm drainage piping system.
- .2 Provide waste and vent connections to plumbing fixtures and equipment.
- .3 Drainage fittings;
 - .1 do not use double hubs, straight crosses, double T's, or double TY's in soil or waste pipe below any fixture,
 - .2 do not use branch fittings other than full "Y" or "Y" and an eighth bend, on soil or waste pipe running in horizontal direction,
 - .3 do not use quarter bend placed on its side,
 - .4 do not use inverted joints below fixtures,
 - .5 do not install cleanouts above food preparation or patient treatment areas. In these areas carry rodding connection up to floor cleanout fitted with adjustable gasketed access cover and plug, with cleanout body cast in floor slab above,
 - .6 drainage fittings to match connected piping for quality and wall thickness.

3.7 Flashings

- .1 Provide flashing for piping penetrations through roofs and other waterproofed areas. Leave flashing ready for Roofing or Waterproofing Trades to make watertight connections.

3.8 Vent Termination (VTR)

- .1 Fit vents passing through roof with vent stack sleeve terminating not less than 150 mm (6 in) above roof, above flood level of roof, and 900 mm (3 ft) above or 3500 mm (11.5 ft) horizontally from any air intake, door, or operable window.

3.9 Water and Waste Connections

- .1 Provide hot and cold water, waste and vent connections to building service equipment. Provide connections to Owners equipment and equipment supplied by Divisions of the Work other than Division 20 to 25, as specified herein and in accordance with specification section 20 05 73.13.
- .2 Provide vacuum breakers and backflow preventers on equipment connections, and hose bibs, and on fixture connections without adequate air gaps.
- .3 Where hot and cold water supply pipes connect to combination supply fitting with shut-off valve on discharge, or where combination supply fitting is equipped with manual or thermostatic mixing valve, equip each hot and cold water supply pipe with composition disc swing check fitting.
- .4 Provide shut-off valve on each service line close to the apparatus and brass traps complete with cleanout on waste connection unless waste discharges directly into floor drain or funnel drain.
- .5 Where specific sizes are not shown, valves, and final connections to equipment to be one pipe size larger than equipment tapping size, and trap and drain size to be one pipe size larger than waste connection on apparatus.

3.10 Pressure Testing – Water Pressure Piping Systems

- .1 Pressure test piping before insulation is applied.
- .2 Initial pneumatic leak test:
 - .1 Conduct an initial pneumatic pressure test at a maximum pressure of 70 kPa (10 psig) prior to hydrostatic pressure test, to check for large leaks or incomplete joints.
 - .2 Remove compressed air source and maintain this pressure for the time necessary to inspect for leaks, but not less than 2 hours.
 - .3 Maintain pressure and examine each joint with commercial leak detector solution.

Standard of Acceptance

- Snoop
 - Leak-tec
- .4 Repair leaks where found prior to performing hydrostatic pressure tests.
- .5 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.
- .3 Final hydrostatic pressure test:
 - .1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.
 - .2 Fill the system with water and gradually increase the system pressure to 150% of the design pressure and hold for 10 minutes, then reduce pressure to the design pressure.
 - .3 Inspect each pipe joint for leaks.
 - .4 As an alternative to inspection of each joint for leaks, conduct a 24 hour standing pressure test:

- (a) raise the water pressure to 150% of the design pressure for 10 minutes, then reduce pressure to design pressure,
 - (b) record the test pressure one (1) hour after establishing the system hydrostatic test pressure at the design pressure. Record ambient air temperature at the same time.
 - (c) at the end of the 24 hour standing test period, record the test pressure and ambient air temperature. Make adjustments to the measured end-of-test pressure to account for change in fluid density due to change in ambient air temperature,
 - (d) acceptance criteria: maximum pressure loss over 24 hours not to exceed 1% of test pressure, corrected for ambient temperature,
 - (e) where acceptance criteria is not met, inspect pipe joints for leaks.
- .5 Where leaks are found, repair leaks and retest piping as specified above.
- (a) for soldered or brazed joints, one attempt at repairing the joint is permitted. If joint continues to fail, cut-out and replace the fitting.

3.11 Pressure Test Report

- .1 Maintain a log of all pressure tests, including locating of where leaks have been repaired. Submit the log to the Consultant for review when requesting prior to substantial completion of the Work. Where a piping system is subject to AHJ inspection, provide evidence of such inspection by means of an AHJ inspection report or name of the AHJ inspector and the date they witnessed the pressure test.

3.12 Flushing and Disinfecting - Water Service Pipe

- .1 Complete piping pressure tests prior to flushing and disinfecting operations. Notify Consultant at least two days in advance of date when disinfecting operations are proposed, so that the Consultant may witness the tests.
 - .2 Isolate the water service pipe inside the building at the point of entry, from the building water distribution system. Flush water service pipes for a minimum of 10 minutes to produce a water velocity of 1.5 m/s (5 fps) and discharge water to drain or other acceptable area.
- .1 Minimum flushing flow rates:

Pipe size	Minimum Flow	
	L/s	USGPM
NPS		
2	3.3	52
2 1/2	4.7	75
3	7.3	115
4	12.6	200
6	23.4	450
8	49	780
10	76	1200
12	110	1750

- .3 Disinfect water service pipes NPS 4 and larger:

- .1 Provide chemicals and equipment to clean, disinfect and flush domestic water service pipes in accordance with AWWA C651.
- .2 Drain down system to remove flushing water.
- .3 Isolate service water pipe from the building distribution system.
- .4 Disinfect water supply pipe by introducing chlorine close to point of connection to the municipal water supply and evenly add to water as water service pipe is refilling, to provide an initial concentration of 50 mg/L.
- .5 Close off drains and maintain chlorinated water in mains pipe for 24 hours.
- .6 At the end of 24 hours, arrange and pay for laboratory testing of water samples taken from newly disinfected main. If the residual chlorine is < 25 mg/L, drain down water and repeat disinfection for an additional 24 hours and lab testing until a residual of minimum 25 mg/L is obtained.
- .7 After the lab test indicates a residual of 25 mg/L, flush line to remove chlorine solution.

3.13 Flushing and Cleaning - Building Water Distribution Piping

- .1 Conduct first fill and pressure testing of building distribution piping only after completion of flushing and disinfection of water service pipe.
- .2 Complete piping pressure tests prior to flushing and cleaning operations.
- .3 Flush water distribution piping through available outlets with sufficient flow to produce velocity of 1.5 m/s, within pipe for 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .4 Minimum flushing flowrates:

Pipe size	Minimum Flow	
NPS	L/s	USGPM
2	3.3	52
2 1/2	4.7	75
3	7.3	115
4	12.6	200

- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .6 When flushing has been completed to satisfaction of Consultant, introduce strong solution of chlorine into watermain and ensure that it is distributed throughout entire system:
 - .1 Drain down system to remove flushing water,
 - .2 Introduce Chlorine close to point of re-filling of system, and evenly add to water as system is refilling, to provide an initial concentration of 50 mg/L
 - .3 Operate valves, hydrants, and appurtenances while main contains chlorine solution.
 - .4 Flush line to remove chlorine solution after 24 hours contact time.
 - .5 Arrange and pay for laboratory testing of water samples taken from newly disinfected main.
 - .6 Where samples do not meet laboratory test standard for potable water, disinfection procedure and testing is to be repeated until satisfactory results are achieved.

3.14 Testing and Balancing – Water Pressure Piping Systems

- .1 Balance domestic water piping systems where double regulating valves are installed, including hot water recirculation piping and as otherwise shown.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

GENERAL-DUTY VALVES FOR PLUMBING PIPING

22 05 23.13

1 GENERAL

1.1 Scope

- .1 Provide valves for general duty service in plumbing piping systems, including shut-off valves, check valves, manual balancing valves, and automatic flow balancing valves.
- .2 Valves under this specification section are provided for:
 - .1 Domestic (potable) water systems using copper tubing, stainless steel pipe or tube, ductile iron water piping, and galvanized steel piping.
 - .2 Non-potable water piping systems including:
 - (a) Process water systems,
 - (b) Irrigation systems,
 - (c) Grey water systems,
 - (d) Pumped sewage systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section integrates with or refers to the following specification sections:
 - .1 20 05 23 General Requirements for Valves
 - .2 22 05 01 Plumbing - General

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Contaminant-free:** means the material is free of contaminants and impurities to the prescribed limits of NSF/ANSI 61 – section 8 (NSF/ANSI 61/8), but excludes evaluation for lead.
 - .2 **Lead-free:** means the weighted average lead content does not exceed 0.25% when evaluated in accordance with the test methods in NSF/ANSI 61-Annex G or NSF/ANSI 372.

1.4 Submittals

- .1 Refer to section 20 05 23.

1.5 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Product standards:
 - .1 CSA B125.3 Plumbing Fittings
 - .2 NSF/ANSI 61 Drinking Water System Components – Health Effects
 - .3 NSF/ANSI 372 Drinking Water System Components – Lead Content (formerly NSF/ANSI 61, Annex G).

2 PRODUCTS

2.1 General

- .1 Where products are specified as being lead-free, they shall be listed to either:
 - .1 CSA B125.3;
 - .2 NSF/ANSI 61-G; or
 - .3 NSF/ANSI 372.
- .2 Where products are specified as being contaminant-free, they shall be listed to either:
 - .1 CSA B125.3;
 - .2 NSF/ANSI 61-G; or
 - .3 NSF/ANSI 61/8

2.2 Ball Valves, brass body (type BV-1)

- .1 NPS 4 and under, copper alloy body:
 - .1 To MSS SP-110, 600 CWP, two-piece bronze or DZR brass body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, solder or NPT threaded ends.
 - .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
 - .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
 - .4 Certified for lead-free and contaminant-free service.
 - .5 Soldered ends: NPS 2 and under.

Standard of Acceptance

- Kitz - fig. 859
- Apollo - fig. 77FLF-20x
- Nibco - fig. S-685-66-LF
- Watts - fig. LFB6081

- .6 Threaded ends: NPS 4 and under.

Standard of Acceptance

- Kitz - fig. 858
- Apollo - fig. 77FLF-10x
- Nibco - fig. T-685-66-LF
- Watts - fig. LFB6080

2.3 Ball Valves, stainless steel body (type BV-2)

- .1 NPS 4 and under, threaded ends:
 - .1 To MSS SP-110, 600CWP, two piece T316 stainless steel body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, NPT threaded ends.
 - .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
 - .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
 - .4 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Apollo - fig. 76F-10x series (NPS 2 and under)
- Watts - fig. S-FBV-1 series

.2 NPS 1- ½ to NPS 12, flanged ends:

- .1 To MSS SP-72, two piece CF8M stainless steel body, full port, stainless steel ball, PTFE seat rings, flanged ends.
- .2 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .3 Certified for lead-free and contaminant-free service.
- .4 ASME Class 150:
 - (a) Required MCPR: 1600 kPa (232 psig) at 93°C (200°F).

Standard of Acceptance

- Apollo - fig. 87A-200 series

.5 ASME Class 300:

- (a) Required MCPR: 4000 kPa (580 psig) at 93°C (200°F).

Standard of Acceptance

- Apollo - fig. 87A-900 series

2.4 Globe Valves (type GLV-1)

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 125 bronze body valves, brass or bronze disc, threaded bonnet, threaded or soldered ends.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

Standard of Acceptance

- Kitz - fig. 812
- Apollo - fig. 121S-LF

.5 Threaded ends:

Standard of Acceptance

- Kitz - fig. 811
- Apollo - fig. 121T-LF

2.5 Gate Valves (type GTV-1)

.1 NPS 2 and under (type GTV-1):

- .1 To: MSS SP-80, Class 125; or MSS SP-139, 300 CWP. Bronze body, solid wedge bronze disc, non-rising stem, screw in or union bonnet, soldered ends.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.

.4 Soldered ends:*Standard of Acceptance*

- Kitz - fig. 808
- Apollo - fig. 102SLF
- Crane (GGC) - fig. LF1320
- Nibco - fig. S-111-LF

.5 Threaded ends:*Standard of Acceptance*

- Kitz - fig. 807
- Apollo - fig. 102TLF
- Crane (GGC) - fig. LF438
- Nibco - fig. T-113-LF

2.6 Gate Valves, Non-Potable Applications (type GTVNP-1)

.1 For non-potable water systems only. Do not use on potable water systems.

.2 NPS 2½ to NPS 12, cast iron:

.1 To MSS SP-70, Class 125, cast iron body with flat faced flange, bronze or bronze faced solid wedge disc with bronze seat rings, OS & Y, bolted bonnet, flanged ends.

(a) Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 72
- Crane - fig. 465 ½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

.3 NPS 2½ to NPS 24, stainless steel:

.1 To ASME B16.34, Class 150, ASTM A216 grade WCB cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet, flanged ends.

.2 ASME Class 150:

(a) Required MCPR: 1700 kPa (246 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 150 SCLS
- Crane - fig. 47 XU-F
- Jenkins - fig. J1009B8F
- Powell - fig. 1503-FC8G

.3 ASME Class 300:

(a) Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 300 SCLS
- Crane - fig. 33 XU-F

- Powell - fig. 3003-FC8G

2.7 Butterfly Valves - Flanged

.1 NPS 2 to NPS 12, ductile iron (type BFV-1):

- .1 To MSS-SP-67, ductile iron lug body style, with flange bolt holes drilled and tapped for ANSI 150 flange pattern.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Stainless steel shaft, aluminum bronze or 316 stainless steel or ductile iron/nickel plated disc, and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Nibco - fig. LD-2000
- Apollo - fig. LD 141, LD 145
- Kitz - fig. 6122EL
- MA Stewart - fig. L-D-4-A-E-LH
- Watts - fig. DBF-03
- Milwaukee - fig. ML233E, ML333E
- Crane Center Line fig. 200

.2 NPS 2 to NPS 12, stainless steel (Type BFV-2):

- .1 To MSS-SP-68, Class 300, CF8M stainless steel lug body style, with flange bolt holes drilled and tapped for ANSI 300 flange pattern.
- .2 Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).
- .3 T316 or 17-4 stainless steel disc and shaft, TFM-PTFE seat complete with titanium or 316 stainless steel spiral wound back-up ring to provide bubble tight shut-off under system pressure from either side, when installed with single flange.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Apollo - fig. 230
- Keystone - fig. K-Lok 37

2.8 Butterfly Valves – Groove Ends

.1 NPS 2 to NPS 12, stainless steel (type BFV-4).

- .1 To MSS SP-67, CF8M stainless steel body, and grooved ends to CSA B242.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Stainless steel shaft, CF8M stainless steel disc, and fluoroelastomer seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.

- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 3, and gear operators for NPS 4 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. Vic 300 MasterSeal series 461

- .2 NPS 2-1/2 to NPS 6, grooved ends for copper tubing (type BFV-5).

- .1 To MSS SP-67, brass or bronze body, grooved ends for copper tubing.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Stainless steel shaft, aluminum bronze disc with fluoroelastomer seat or ductile iron with EPDM encased disc/seal combination.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 6.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. Vic 608N
- Gruvlok - fig. AN6721

2.9 Inline Silent Check Valves

- .1 NPS 2 and under:

- .1 To MSS SP-80, Class 125, bronze or stainless steel body, inline spring-actuated disc or ball type, and PTFE or EPDM seat.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.
- .4 Soldered ends:

Standard of Acceptance

- Nibco – fig. S-480-Y-LF
- Apollo – fig. CVB-LF (61LF-600)
- Kitz – fig. 826

- .5 Threaded ends:

Standard of Acceptance

- Nibco - fig. T-480-Y-LF
- Apollo - fig. CVB-LF (61LF-500)
- Kitz - fig. 836

- .2 NPS 2 to NPS 12:

- .1 To MSS SP-125, cast iron body with flat faced flange or wafer body, inline spring-actuated silent type, replaceable PTFE or BUNA-N seats, bronze faced iron or bronze disc.
- .2 Required MCPR: 13200 kPa (188 psi) at 65°C (150°F).

.3 Certified for lead-free and contaminant-free service.

.4 Class 125:

(a) Required MCPR: 1380 kPa (200 psi) at 65°C (150°F).

Standard of Acceptance

- Nibco - fig. F-910-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

.5 Class 250:

(a) Required MCPR: 2700 kPa (392 psi) at 65°C (150°F).

Standard of Acceptance

- Nibco - fig. F-960-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

.3 NPS 2 and over, grooved ends:

.1 CF8M stainless steel body with spring-assisted twin stainless steel discs, and fluoroelastomeric seat.

.2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).

.3 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. 816

2.10 Swing Check Valves – Non-slam

.1 For building sump pumps service only.

.2 NPS 2 and larger, flanged:

.1 To MSS SP-71, Class 125, swing check type with external lever weight and/or spring closure, cast iron body, renewable bronze seat rings, bronze faced iron or bronze disc, bolted cap, flanged ends.

.2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

Standard of Acceptance

- Val-Matic - fig. 7800LW / 7800LS
- DeZurik - fig. APCP swing check

2.11 Double Regulating Valves (DRVLF)

.1 NPS 3 and under, threaded or soldered:

.1 Brass body, plug type stem with flow measurement ports and tamper-proof setting.

.2 NPT threaded or soldered ends.

.3 Required MCPR:

(a) Soldered: 2000 kPa (300 psig) at 93°C (200°F).

(b) Threaded: 2750 kPa (400 psi) at 93°C (200°F).

.4 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Bell and Gossett - fig. CB-*-LF, RF-*-LF
- Nexus - fig. Ultra MBNL
- Victaulic/Tour and Anderson - fig. 78BL

.2 Flow meter for DRVs:

- .1 Differential pressure gauge with calibration charts or digital flow meter type.
- .2 Hoses and fittings to suit manual double regulating valves.

Standard of Acceptance

- Bell and Gossett - Readout Kit
- Nexus - Meter Kit, MKM series

2.12 Automatic Flow Balancing Valve**.1 NPS ½ to NPS ¾, threaded:**

- .1 Automatic flow balancing valve providing constant flow rate over a wide differential pressure control range.
- .2 Stainless steel or brass body, with stainless steel cartridge and EPDM seals.
- .3 Performance:
 - (a) +/- 5% flow rate over 95% of control range.
 - (b) Differential pressure control range: minimum of 14 to 220 kPa (2 to 32 psi) operating range.
- .4 NPT threaded ends.
- .5 Minimum MCPR: 2750 kPa (400 psi) at 93°C (200°F).
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic/Tour and Andersson - fig. 76X
- Griswald Controls - fig. K Valve

3 EXECUTION**3.1 Installation**

- .1 Refer to section 20 05 23 and as required herein.
- .2 Use certified lead-free and contaminant-free valves on potable cold, hot and recirculating water systems. Valves not certified as lead-free may only be used on non-potable water systems, pumped drainage systems and other similar systems.

3.2 Valve Selection Based on Pressure Rating

- .1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 22 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:

- .1 For all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.
- .2 For clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

3.3 Manual Valve Selection Based on Service and Pipe Material

- .1 Select manual valve types based on the requirements of Table 1.

Table 1: Manual Valve Selection		
Piping System	Pipe and Tube Material	Manual Valve Type
Domestic Cold Water Domestic Hot Water Domestic Recirculating Water Domestic Tempered Water	Copper	BV-1 GLV-1 GTV-1 BFV-1, BFV-2, BFV-5
	Stainless Steel	BV-2 BFV-2, BFV-4
	Ductile Iron	BFV-1, BFV-2
Domestic Cold Water (Industrial Occupancies only)	Galvanized steel	BV-1 GTV-2 BFV-1, BFV-3
Non-potable water	Copper	BV-1 GLV-1 GTV-1 BFV-1, BFV-2, BFV-5
	Stainless Steel	BV-2 BFV-2, BFV-4
	Galvanized Steel	BV-1, BV-2 GLV-1 GTV-1, GTVNP-1 BFV-1, BFV-2, BFV-3, BFV-4
Pumped Sanitary Drainage Pumped Storm Drainage	Copper	BV-1, BV-2
	Galvanized Steel	BV-1, BV-2

3.4 Check Valves

- .1 Select check valves based on the requirements of Table 2.

Table 2: Check Valve Type Selection	
General use	Inline silent check
Domestic water heaters	Inline silent check
Temperature mixing valves	Inline silent check
Elevator sump pump discharge Clear waste sump pump discharge	Inline silent check or non-slam swing check
Sanitary sump pump discharge Storm sump pump discharge	Non-slam swing check valve

3.5 Automatic Flow Balancing Valves

- .1 Select automatic flow balancing valves to suit the flow rates as shown at a pressure differential of 35 kPa (5 psig). Where the indicated flow rate falls between two catalogued values, select the lower flow rated valve.

End of Section

TESTING ADJUSTING AND BALANCING FOR PLUMBING

22 05 93

1 GENERAL

1.1 Scope

- .1 Test, adjust, and balance ("TAB") plumbing systems installed, modified or extended as part of this work, including:
 - .1 domestic cold water booster pumps,
 - .2 domestic hot water systems,
 - .3 domestic hot water recirculation systems

1.2 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.3 Accuracy

- .1 Adjust systems until operating values are within the acceptance criteria stated for each system type. Where an acceptance criterion is not stated, balance the system so that measured values are within $\pm 5\%$ of design value.
- .2 Measurement device accuracy:

Measurement	Application	Device	Accuracy
Liquid Flow	Piping	Installed meter	As per meter rating
Liquid Flow	Equipment	Differential Pressure and equipment data	See below
Temperature	Liquids	Digital Electronic Thermometer	$\pm 0.2^{\circ}\text{C}$ over 0 to $+40^{\circ}\text{C}$
Temperature	Liquid	Digital Electronic Thermometer	$\pm 0.4^{\circ}\text{C}$ < 0°C and $>+40^{\circ}\text{C}$
Pressure	Liquid, Gas, Steam	Bourbon type	$\pm 1.0\%$ of reading
RPM	Motor, fans	Chronometer tachometer	$\pm 1.0\%$ of reading
Voltage	All	Portable	$\pm 2.5\%$ of reading
Current	All	Portable clamp-on ammeter	$\pm 2.5\%$ of reading

1.4 Audit Verification

- .1 After review of the draft TAB report by Consultant, the Consultant may at their sole discretion require re-measurement of TAB results on an audit sample rate of 5% of all measured equipment, at no cost extra to the Contract Price or change to project schedule.
- .2 If audited results indicate a variance of more than 10% between the original reported value and the audit measured value for a piece of equipment, re-balance the audited device. If this excessive variance condition occurs at more than 25% of the number of audited equipment sample, re-balance the entire affected system at no cost extra to the Contract Price or change to project schedule.

1.5 Preparatory Work

- .1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.
- .2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated. Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, and balancing valves.
- .3 Commence TAB measurements when building is “closed in” and work is sufficiently advanced including;
 - .1 permanent heating is in operation,
 - .2 potable water systems have been flushed and cleaned.

1.6 Measurement Parameters

- .1 Reporting units of measure:

Parameter	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Volume	litre	L
Volume flow rate	Litres per second	L/s
Time	seconds	s
Temperature	Celsius	°C
Pressure	kilopascal	kPa
Pump Head	metre	m
Pump Pressure	kilopascals	kPa
Mass flow rate	kg per second	kg/s
Heat flow rate	kilowatts	kW
Electrical Power	kilowatts	kW
Voltage	Volts	V
Electrical Current	amps	A
Rotation speed	Rotations per minute	RPM

2 EXECUTION – DOMESTIC WATER DISTRIBUTION

2.1 Measurement Parameters

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
 - .1 volume flow rate,
 - .2 temperature,
 - .3 pressure (gauge),

- .4 equipment related;
 - (a) rotational speed (rpm),
 - (b) electrical power, kW
 - (c) voltage, V
 - (d) current, A,
- .2 Measurement are required at and around equipment to establish fluid side performance of;
 - .1 domestic water heaters and heat exchangers.
 - .2 domestic water booster pumps,
 - .3 hot water recirculation pumps.
- .3 Measurement are required to characterize system performance;
 - .1 water flowrates at plumbing fixtures,
 - .2 hot water recirculation flow rates.

2.2 General Requirements

- .1 Use permanent water flow meters, temporary non-invasive flow meters, or metered fittings and pressure gauges to determine flow rates for system balance.
- .2 Base flow balance flow rates on (in order of preference):
 - .1 permanent flow meters,
 - .2 temporary non-invasive flow meters,
 - .3 double regulating valves,
 - .4 differential pressure measurement across heat transfer elements, with flowrate determined from manufacturer's literature, or

2.3 Domestic Cold Water Booster Pump Test Procedure

- .1 For new building;
 - .1 open only sufficient number of fixture outlets to cause a minimum pump flow condition, with only one booster pump operating at minimum speed. Record pump performance results.
 - .2 open sufficient number of fixture outlets to cause the design number of booster pumps to start and to run to maximum design pump speed. Record pump performance results.
 - .3 reduce the number of fixture outlets to cause the booster pumps to operate at approximately 50% of design flow rates. Record pump performance results.
- .2 For installation of booster pumps in existing buildings;
 - .1 place pumps into service, and monitor pump performance under building load for a 24 hour period. Use a data-logger to monitor pump differential pressure and motor current. Alternatively, a building control system may be configured to collect this data.

2.4 Hot Water Recirculation Balancing Procedure

- .1 Where circuit-balancing valves are used on hot water recirculation systems, adjust each valve to obtain the required design flow rate.
- .2 Where pressure-independent flow regulating valves are used in a hot water recirculation system, for each valve;

- .1 measure system static pressure at the closest service sink to the pressure-independent flow control valve where a pressure gauge may be added to the faucet outlet ("adjacent system inlet static pressure"), and record system static pressure at the at-test system operating condition,
- .2 measure system static pressure at the inlet to the recirculating pump,
- .3 verify model type and size of each pressure-independent flow regulating valve and record results in the TAB report. Include the following data for each valve:
 - (a) location of flow control valve (i.e. floor level, room reference),
 - (b) adjacent system inlet static pressure,
 - (c) recirculation pump inlet static pressure,
 - (d) calculated differential pressure estimate (excluding pipe friction losses),
 - (e) valve model and size, with flow rate at the calculated differential pressure.

2.5 Plumbing Fixtures Hot Water Test Procedure

- .1 At each floor level, measure the cold and hot water static pressure at the outlet of any fixture that can have a pressure gauge attached to it.
- .2 For plumbing fixtures with automatic hot water temperature or pressure control, test and set each fixture as follows:
 - .1 flow hot water from the fixture for a sufficient time to stabilize hot water temperature,
 - .2 if hot water temperature is greater or less than specified water supply temperature, adjust fixture to obtain required hot water outlet temperature,
 - .3 record adjusted temperature results for all fixtures.
- .3 For sinks and lavatories, perform the following hot water time-to-delivery test;
 - .1 randomly select 10% of all fixtures, evenly distributed by type and over each floor, with selections approved by Consultant,
 - .2 do not select a fixture where it shares a portion of a hot water dead-leg pipe with another selected test fixture,
 - .3 allow each floor to be at rest (no water flow from plumbing fixtures) for a period of 24 hours prior to conducting the time-to-delivery test,
 - .4 at each fixture, run hot water (or tempered water for fixtures with blending valves) into a receptacle that has a bottom outlet, with the outlet sized to allow water to collect in and simultaneously drain from the receptacle. Record the time required for the hot water in the receptacle to stabilize at the expected water outlet temperature,
 - .5 after completion of the preceding test, measure the flow rate from the fixture using another receptacle and a stop-watch,
 - .6 record the time-to-delivery of design hot water temperature and measured flow rate for each selected fixture. Include the fixture type and room location of the fixture.

3 EXECUTION - EQUIPMENT TESTING

3.1 Performance Data

- .1 Submit the following data as a minimum. If contractor's standard forms provide for additional data, also submit such additional data.
- .2 Include nameplate data and as-tested results.

.3 Hot water heaters:

- .1 manufacturer and model,
- .2 heat output rating (kW),
- .3 electric power input rating (kW),
- .4 gas and fuel oil input flow rating,
- .5 gas and fuel oil input pressure rating (minimum, maximum),
- .6 gas pressure regulator inlet and outlet pressure,
- .7 pressure rating (MAWP),
- .8 pressure relief valve rating (pressure setpoint, heat rating, steam rating),
- .9 heat performance:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) liquid flow rate (minimum, maximum),
 - (d) steam flow rate and pressure,
 - (e) calculated heat output rating at measured design water flow rate and measured temperatures.

.4 Hot water heat exchangers:

- .1 manufacturer and type,
- .2 inlet and outlet temperatures,
- .3 pressure drop,
- .4 design pressure rating (MAWP),
- .5 heat performance:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) liquid flow rate (minimum, maximum),
 - (d) input steam flow rate and pressure (where applicable),
 - (e) calculated heat output rating at measured design water flow rate and measured temperatures.

.5 Pumps:

- .1 manufacturer name,
- .2 model or serial number,
- .3 flow rate,
- .4 developed pump head,
- .5 RPM.

4 EXECUTION - MISCELLANEOUS

4.1 Balance Position Marking

- .1 Mark the balance position of valves at the completion of the final testing:

- .1 valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.
- .2 Additional requirements for circuit-balancing valves with test ports:
 - .1 remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

5 EXECUTION - REPORT PRESENTATION AND VERIFICATION

5.1 Required Reports

- .1 Provide the following reports:
 - .1 Water balancing and equipment test report.

5.2 Record Keeping

- .1 Keep records of trial and final balance and submit preliminary report as each system is completed.
- .2 Do not submit the final TAB report until all audit verification re-measurements, and any required re-balancing, is completed to the satisfaction of Consultant.

5.3 Report Format

- .1 Reports to incorporate approved standard forms, with values expressed in the same units as shown on Contract Documents.
- .2 Include "as-built" system schematics, marked-up to show as-measured flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for reference.
- .3 Submit an electronic PDF copy of the draft TAB report for review by Consultant. Where a report page length is more than 20 pages, include bookmarks in the PDF document organizes by system number and/or name.
- .4 After any revisions requested by Consultant have been made and final review accepted by Consultant, submit the final TAB report in the following formats:
 - .1 two (2) hard copies of the completed report, each with index tabs and bound in "D" ring binders,
 - .2 electronic file PDF copies by email or drop-box as coordinated with Owner and Consultant.

5.4 Completion

- .1 Continue TAB until reports are approved.
- .2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.
- .3 The substantial performance of the Work is not dependent upon alternate season testing.
- .4 The total performance of the Work will not be considered reached until the alternate season testing and balancing is completed and the final report submitted has been reviewed by Consultant and accepted by the Owner.

END OF SECTION

DOMESTIC WATER PIPING - COPPER 22 11 16.13

1 GENERAL

1.1 Scope

- .1 Provide copper tube and fittings for potable domestic water piping systems for aboveground installations.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 22 05 01 Plumbing Piping Systems – General Requirements
 - .3 22 05 23.13 General-duty Valves for Plumbing Piping
 - .4 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Definitions

- .1 The following definitions apply to this specification section:
 - .1 **Exposed areas:** include inside service rooms and above lay-in tile ceilings, but excludes: vertical and horizontal service shafts; above any other ceiling construction; and inside walls and partitions.

1.4 Applicable Codes and Standards

- .1 Installation standards:
 - .1 Copper Development Association (CDA) Copper Tube Handbook
- .2 Product standards:
 - .1 ASTM B88 Standard Specification for Seamless Copper Water Tube
 - .2 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
 - .3 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - .4 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .5 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
 - .6 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
 - .7 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - .8 ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature
 - .9 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - .10 ASTM B-32 Specification for Solder Metal
 - .11 AWS A5.8 Brazing Filler Metal.
 - .12 CSA B242 Groove and Shouldered Type Mechanical Couplings

.13 MSS SP-106 Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300

2 PRODUCTS

2.1 Copper Tube

- .1 Hard drawn, type L.
- .2 Listed to ASTM B88 and to have certification markings made by testing agency accredited by Standards Council of Canada.

2.2 Fittings

- .1 Brass or bronze flanges and flanged fittings: to ASME B16.24.
- .2 Brass or bronze threaded fittings: to ASME B16.15.
- .3 Solder/brazed fittings: cast bronze to ASME B16.18, or wrought copper and bronze to ASME B16.22.
- .4 Threaded fittings including unions to ASME B16.15, Class 250.
- .5 Roll groove full flow standard radius cast bronze fittings for sizes NPS 2 1/2 and larger: to CSA B242

2.3 Joints

- .1 Solder: 95:5 tin-antimony solder to ASTM B-32.
- .2 Silver brazing alloy to AWS A5.8 classification BCUP-5.

Standard of Acceptance

- Handy Harman "SIL-FOS"
- All-State Welding Alloys "SILFLO 15"

.3 Flanges:

- .1 Threaded end connection: flat face, cast copper alloy to ASME B16.24, class 150 and 300, NPT threaded,
- .2 Brazed end connection: flat face, cast copper alloy to MSS SP-106, class 150 or 300.
- .3 Dielectric flanges: to specification section 22 05 01.
- .4 Studs and bolts: stainless steel to ASTM A193.
- .5 Nuts: stainless steel type 316, to ASTM A194.

.4 Flange gaskets:

- .1 Full flat-faced style to ANSI B16.21.
- .2 Suitable for use in potable water service and listed to NSF/ANSI 61.
- .3 Ethylene propylene diene monomer (EPDM);
 - (a) required working pressure: 1700 kPa (250 psi) at up to 95°C (203°F)
- .4 Compressed mineral fibers bonded with nitrile (NBR);
 - (a) required working pressure: 2750 kPa (400 psi) at up to 95°C (203°F)

Standard of Acceptance

- American-Biltrite (EPDM) – fig. AB-576
- Durlon (NBR) – fig. 7910

.5 Roll grooved piping:

- .1 Roll groove positive clamp gasketed couplings or roll groove flange adapters for copper piping to CSA B242.

Standard of Acceptance

- Victaulic - fig. 607
- Gruvlock
- Couplox
- Shurjoint

3 EXECUTION

3.1 Installation

- .1 Refer to section 22 05 01 for piping design criteria and general requirements for piping installation.
- .2 Install tubing close to building structure to minimize furring and conserve headroom. Group tubing and run parallel to walls and ceilings.
- .3 Cut tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .4 Before making solder or brazed joints, remove working parts of valves, clean inside of solder fittings and outside of mating pipe with emery paper and coat with applicable flux.

3.2 Pipe Supports

- .1 Support piping and tubing in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper tubing at intervals in accordance with Table 1:

Table 1: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .1 Support vertical pipe and tube risers;
- .1 at the base (bottom) of the riser by a support that is independent of any adjacent horizontal pipe supports,
- .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 7.5 m (24.5 ft).

3.3 Class Rated Fittings

- .1 Select ASME Class rated fittings and flanges in accordance with the following Table 2 for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Table 2: Pressure and Temperature Limits for Class Rated Fittings		
Class	Maximum Design Pressure	Maximum Coincident Design Temperature
150	1720 (250 psi)	≤ 38°C (100°F)
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3700 kPa (535 psi)	≤ 38°C (100°F)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

3.4 Joints and Fittings

- .1 Joints in tubing:
- .1 NPS ½ to NPS 2:
 - (a) soldered.
 - .2 NPS 2-1/2 and larger:
 - (a) brazed, flanged or roll-grooved joints.
- .2 Make solder joints in accordance with the recommendations of the CDA handbook.
- .3 Make braze joints in accordance with specification section 20 05 24.
- .4 Use manufactured fittings. Use of fabricated pulled-tee's is subject to approval by the local municipal authority for plumbing, and only brazed butt weld joints shall be used.
- .5 For flange joints, select gasket materials in accordance with the following Table 3 so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Table 3: Flange Gasket Selection				
Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Figure
95°C (203°F)	1720 kPa (250 psig)	EPDM	1.5 m (1/6 in)	A-B AB-576
	2750 kPa (400 psig)	NBR	1.5 m (1/6 in)	Durlon 7910

3.5 Groove Joint Piping

- .1 Make pipe ends clean and free of indentations, projections and roll marks, between the end of the pipe and the groove.
- .2 Verify gasket style and material grade with supplier for use with intended service.
- .3 Provide for manufacturers' service representative to conduct on-site training prior to piping rough-in and installation.
- .4 Arrange and pay for a factory-trained representative to periodically visit the place of the Work and review the installation for compliance with the manufacturer's installation instructions.
 - .1 Correct any identified deficiencies.
 - .2 Correct any product that has been examined and which has not met the visual inspection criteria for proper installation
 - .3 Arrange and pay for re-examination by the manufacturer's representative after deficiencies have been corrected and/or materials replaced to verify the corrected installation prior to filling the system for testing or placing into service.

3.6 Equipment Connections

- .1 Make pipe connections to equipment as follows.
 - .1 NPS 2 and smaller: threaded fittings.
 - .2 NPS 2 ½ and larger:
 - (a) flanged connections, or
 - (b) grooved end where equipment has compatible factory-prepared grooved ends.
- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.
- .3 For threaded flanges, provide a sweat x NPT adaptor; do not thread tubing directly.
- .4 Provide a dielectric union or dielectric flange in accordance with specification section 22 05 01 when connecting potable water piping to equipment with carbon steel connections. Dielectric fittings are not required when connecting to equipment with stainless steel connections.

3.7 Valves

- .1 Provide valves in accordance with specification section 22 05 23.13.
 - .1 Isolate equipment, fixtures and branches with gate, ball or butterfly valves.
 - .2 Use globe, DRVs, ball or butterfly valves for throttling service.

3.8 Pressure Testing, Flushing and Balancing

- .1 Pressure test, flush and balance water systems to specification section 22 05 01.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

DOMESTIC WATER PIPING SPECIALTIES

22 11 19

1 GENERAL

1.1 Scope

- .1 Provide domestic water piping specialties and accessories.

1.2 Applicable Codes and Standards

- .1 Product standards:
 - .1 ANSI/ASSE 1010 Water Hammer Arrestors
 - .2 CSA-B125 Plumbing Fittings.
 - .3 CSA B.64.1.1 Atmospheric Vacuum Breakers (AVB)
 - .4 CSA B.64.1.2 Pressure Vacuum Breakers (PVB)
 - .5 CSA B64.2.1 Hose Connection Vacuum Breaker (HCVB) with Manual Drain Feature
 - .6 CSA B.64.4 Backflow Preventers, Reduced Pressure Principle (RP)
 - .7 CSA B64.10 Manual for the Selection and Installation of Backflow Prevention Devices/Manual for the Maintenance and Field Testing of Backflow Prevention Devices
 - .8 CSA B137.6 Chlorinated Polyvinylchloride (CPVC) Pipe, Tubing, and Fittings for Hot- and Cold-Water Distribution Systems
 - .9 CSA C22.2 No. 14 Industrial Control Equipment
 - .10 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .11 NSF/ANSI 61 Drinking Water System Components – Health Effects
 - .12 NSF/ANSI 372 Drinking Water System Components – Lead Content
 - .13 PDI-WH201 (Plumbing and Drainage Institute) Standard Water Hammer Arresters

1.3 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 Wall Hydrants

- .1 Concealed key operated non-freeze type;
 - .1 integral vacuum breaker,
 - .2 stainless steel or bronze box,
 - .3 hinged locking door,
 - .4 galvanized casing,
 - .5 adjustable wall flange.

Standard of Acceptance

- Jay R. Smith - fig. 5509QT
- Mifab - fig. MHY-26

- Zurn - fig. Z-1320

- .2 Key operated non-freeze type;
 - .1 integral vacuum breaker,
 - .2 stainless steel, nickel bronze or chrome plated body and backer plate,
 - .3 removable key operator.

Standard of Acceptance.

- Jay R. Smith - fig. 5609QT
- Mifab - fig. MHY-16
- Zurn - fig. ZN-1321

2.2 Water Hammer Arresters

- .1 Stainless steel construction with precharged air chamber of nesting bellows.
- .2 Selected in accordance with Plumbing and Drainage Institute Standard PD1-WH201.
- .3 Listed to ANSI/ASSE 1010

Standard of Acceptance

- Jay R. Smith - fig. Hydrotrol 5000 series
- Mifab - fig. WHB series
- Zurn - fig. Shocktrol Z-1700 series]

2.3 Trap Seal Primers

- .1 Electrically operated manifold units – Type A:
 - .1 factory assembled in 1.5 mm (16 ga) recessed metal cabinet with hinged stainless steel lockable access door,
 - .2 atmospheric vacuum breaker,
 - .3 24 hr controller with manual over ride switch,
 - .4 120 Volt solenoid valve,
 - .5 NPS ¾ or NPS ½ valved inlet water connection,
 - .6 calibrated water distribution manifold,
 - .7 NPS ½ outlet compression fittings,
 - .8 power supply: 120 VAC.

Standard of Acceptance

- Precision Plumbing Products - fig PT-3 thru PT-30
- Mifab - fig.MI-100

- .2 Electrically operated manifold units – Type B:
 - .1 Same as Type A electronic trap seal primer, except distribution manifold is shipped loose for field installation external to the trap primer cabinet.

2.4 Back-flow Preventers - Reduced Pressure Principle ("RP")

- .1 Listed to CSA B.64.4.
- .2 NPS ½ to 2:
 - .1 two independent check valves with intermediate relief valve,
 - .2 quarter turn full port resilient seated ball valves,
 - .3 inlet strainer,
 - .4 ball test cocks,
 - .5 air gap drain,
 - .6 lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. LF909QT
- Apollo - fig. RPLF4A

- .3 NPS 2 to 10:
 - .1 two independent check valves with intermediate relief valve,
 - .2 OS&Y ULC listed resilient seated gate valves,
 - .3 ball test cocks,
 - .4 air gap drain body,
 - .5 lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. LF909-OSY
- Apollo - fig. RPDA40
- Cla-val Company - fig. RP-1EX

2.5 Vacuum Breakers

- .1 Atmospheric type ("AVB"):
 - .1 listed to CSA B.64.1.1.
 - .2 NPS ¼ to 3:
 - (a) atmospheric type (AVB), with single float and disc, and
 - (b) large atmospheric port.

Standard of Acceptance

- Watts - fig. 288A
- Cash Acme - fig. V-101

- .2 Pressure type ("PVB"):
 - .1 listed to CSA B.64.1.2.
 - .2 NPS ½ to 2:
 - (a) pressure type (PVB) with spring loaded single float and disc,
 - (b) independent first check, shut off valves, and ball type test cocks.

Standard of Acceptance

- Watts - fig. 800

.3 Hose connection type ("HCVB"):

- .1 listed to CSA B.64.2
- .2 NPS $\frac{3}{4}$:
 - (a) atmospheric vent vacuum breaker with non-removable single check,
 - (b) hose connection,
 - (c) drainage feature to prevent freezing,

Standard of Acceptance

- Watts - fig. 8
- Cash Acme – fig. V-3

2.6 Backflow Preventer Valve Cabinets

- .1 Recessed mount,[stainless steel with No. 4 satin polish finish
- .2 1.2 mm (16ga) welded one piece tub with adjustable face frame,
- .3 Solid door with rounded safety cornered door, continuous exposed piano hinge and cam latch,
- .4 Integral 50mm (2") high drain pan at bottom of tub, sloping to an NPT 1" center drain outlet,
- .5 Hole punching for piping penetrations as shown.
- .6 Cabinet size:
 - .1 single valve : 826mm x 762mm x 152mm (32 $\frac{1}{2}$ " x 30" x 6") deep
 - .2 double valve: 826mm x 1219mm x 152mm (32 $\frac{1}{2}$ " x 48" x 6") deep

Standard of Acceptance

- Acudor - fig. BFP-1 for single valves
- Acudor - fig. BFP-2 for double valves

2.7 Pressure Reducing Valves

- .1 Bronze body, self-contained type, single renewable nickel alloy seat and resilient disc.
- .2 Diaphragm suitable for 90°C (200°F) service.
- .3 Close coupled bronze strainer with stainless steel screen.
- .4 Required MCPR: 2060 kPa (300 psi) at 49°C (120°F).
- .5 Flow rates and pressure reduction: as shown on drawings.
- .6 Lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts
- Cash Acme Valve
- Singer Valve
- Leslie
- Victaulic Bermad

2.8 Pressure Relief Valves

- .1 Brass body to ASME Section IV.
- .2 Preset pressure settings: 515, 700, 860 and 1030 kPa (75, 100, 125 and 150 psi).
- .3 Lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. LF3L

2.9 Strainers

- .1 NPS ½ to NPS 3:
 - .1 wye pattern, bronze body, solid retainer cap with gasket, and NPT threaded or soldered end,
 - .2 type 304 stainless steel baskets: 1.2 mm (3/64 in) diameter perforations,
 - .3 required MCPR: 2750 kPa (400 psi) at 93°C (200°F)
 - .4 lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. LF777, LFS777
- Zurn - fig. YBXL
- Cash Acme

- .2 NPS 4 to NPS 10:
 - .1 simplex basket strainer, cast iron body, bolted screen retainer cover, plugged drain/blowdown NPT connection, ASME Class 125 flat faced flange ends,
 - .2 type 304 stainless steel baskets: 3.2 mm (1/8 in) diameter perforations,
 - .3 required MCPR: 1370 kPa (200 psi) at 66°C (150°F),
 - .4 lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. LF98FB-CIB

2.10 Expansion Tanks

- .1 Diaphragm style:
 - .1 carbon steel body, butyl diaphragm, airside factory pre-charged to 80 kPa (12 psi), and stainless steel NPT pipe connections,
 - .2 required MCPR: 1000 kPa (150 psig) at 93°C (200°F)
 - .3 lead free and listed to NSF/ANSI 61/G or 372.

Standard of Acceptance

- Watts - fig. PLT

3 EXECUTION

3.1 Wall Hydrants

- .1 Install between 600 mm and 750 mm (24 and 30 in.) above finished grade level.

3.2 Water Hammer Arresters

- .1 Select and install water hammer arrestors in accordance with PDI-WH 201 on branch supplies to each fixture or group of fixtures.

3.3 Trap Seal Primers

- .1 Electronic manifolds:
 - .1 Install trap seal primer panels in the locations as shown on drawings to serve individual or groups of floor drains and/or hub drains.
 - .2 120V/1ph/60 Hz power supply will be brought to electric manifolded units under Division 26 and connected under Division 22.
 - .3 For Type B trap primer unit, pipe the outlet of the primer unit in type L hard-drawn copper down through the floor slab and connect to the trap primer distribution manifold located in ceiling space below.
- .2 Trap primer tubing:
 - .1 Use soft annealed copper tube to connect trap primer distribution manifold to floor drains and/or funnel drains.

3.4 Back-Flow Preventers and Vacuum Breakers

- .1 Provide back-flow preventers and vacuum breakers in accordance with CSA B64.10.
- .2 Install backflow preventers horizontally, in accordance with manufacturer's recommendations, but not less than 750 mm (30 in.) and not greater than 1500 mm (59 in.) above the floor level, or a fixed work platform, in front of the valve.
- .3 Install pressure vacuum breakers not more than 1500 mm (56 in.) above the floor level, or a fixed work platform, in front of the valve.
 - .1 Exception: where the pipe connection to the protected fixture or equipment is higher than 1500 mm (56 in.) above the floor, locate the pressure vacuum breaker at an elevation just high enough so that the outlet pipe to the fixture/equipment does not rise above the vacuum breaker.
- .4 Pipe discharge from backflow preventer, with air gap, to nearest floor/hub drain or service sink using hard-drawing DWV copper tube.
- .5 Position backflow preventers and pressure vacuum breakers so that test ports are accessible.

3.5 Pressure-Reducing Valves

- .1 Install pressure-reducing valves ("PRV") with upstream and downstream shut-off valve and unions, and provide a 115 mm (4½ in) pressure gauge immediately downstream of the PRV.
- .2 For high-flow/low-flow parallel PRV arrangements, install the high-flow valve in the pipe main run and the low-flow valve in the offset run. Set the low-flow PRV setpoint to be 35 to 70 kPa (5 to 10 psi) greater than the high-flow PRV setpoint.

3.6 Pressure Relief Valves

- .1 Install pressure relief valves (PV) in locations shown. Select relief valve setpoint to be not more than the design pressure of the piping system.

3.7 Strainers

- .1 Install with sufficient space to remove baskets.

- .2 Provide a valved blow-down drain line on NPS 4 to NPS 10 basket strainers, and pipe blow-down line in hard type L copper tube and terminate over floor drain, hub drain or trench drain.

3.8 Expansion Tank

- .1 Provide expansion tanks as follows:
 - .1 after each pressure reducing valve,
 - .2 after each backflow preventer, and
 - .3 where shown on drawings.
- .2 Install tank on cold water line immediately before the connection to the domestic hot water tank or heater, and after the cold water check valve.
- .3 Provide lockshield shut-off valve and pressure gauge on water line to expansion tank.
- .4 Check and adjust pressure charge in accordance with manufacturer's instructions.
 - .1 Set minimum pressure on tank before domestic hot water piping is warmed up.
 - .2 Where the expansion tank is located at the bottom of a riser, increase the factory pre-set pressure charge by 10 kPa per 1 meter (1.3 psi per 3 feet) of riser height above the tank, before filling the water piping system with water.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SANITARY WASTE AND VENT PIPING – CAST IRON AND COPPER

22 13 16.13

1 GENERAL

1.1 Scope

- .1 Provide cast iron pipe and fittings and/or copper tube and fittings for sanitary soil and waste drain and vent piping, for aboveground and buried services.
- .2 Provide PVC-DWV piping for urinal fixture drains and a portion of the fixture vent piping.
 - .1 For clarity, the use of PVC DWV piping under this specification section is restricted to this purpose.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 25 Excavation and Backfilling
 - .2 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Applicable Codes and Standards

- .1 Installation standards and codes:
 - .1 Cast Iron Soil Pipe Institute (CISPI) Technical Manual
- .2 Product standards:
 - .1 ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings: DWV
 - .2 ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings-DWV
 - .3 ASTM B32 Standard Specification for Solder Metal
 - .4 ASTM B306 Standard Specification for Copper Drainage Tube (DWV)
 - .5 ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - .6 ASTM C1540 Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
 - .7 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - .8 CSA B70 Cast Iron Soil Pipe, Fittings, and Means of Joining
 - .9 CSA-B125 Plumbing Fittings.
 - .10 CSA B158.1 Cast Brass Solder Joint Drainage, Waste, and Vent Fittings
 - .11 CSA B602 Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

2 PRODUCTS

2.1 Copper DWV Pipe and Fittings

- .1 Application: inside of buildings only. Do not use for buried drain or vent.
- .2 Pipe:
 - .1 copper DWV tube to ASTM B306

- .2 certification markings made by testing agency accredited by Standards Council of Canada.
- .3 Fittings:
 - .1 copper or copper alloy to ASME B16.23, or ASME B16.29.
- .4 Solder
 - .1 tin-antimony 95/5 to ASTM B32 alloy Sb5.

2.2 Cast Iron DWV Pipe and Fittings

- .1 Application: inside of buildings and buried drain and vent.
- .2 Pipe and fittings:
 - .1 cast to CSA B70,
 - .2 with heavy bituminous coating for buried service.
 - .3 riser fittings with integral riser support ring for hub-less piping installed in vertical risers.
- .3 Joints above ground:
 - .1 Plain end made up using mechanical sleeve joints to CSA B602 and ASTM C1540 with neoprene or butyl rubber compression gaskets to ASTM C564, with stainless steel sleeve and not less than four stainless steel drive clamps with stainless steel worms.
 - .2 Hub and spigot made up neoprene gasket to ASTM C564 and lubricating compound.

2.3 PVC DWV Pipe and Fittings

- .1 Application:
 - .1 Restricted to fixture drain piping and partial vent pipe for urinals.
- .2 Pipe and fittings:
 - .1 PVC pipe and fittings to CSA-B181.2,
 - .2 flame spread rating ("FSR") of not more than 25 when tested to ULC-S102.2,
 - .3 smoke developed rating ("SDR") of not more than 50 when tested to ULC-S102.2.
 - .4 materials marked for CSA B181.2 and ULC-S102.2.

Standard of Acceptance

- IPEX -"System XFR 15-50"
- .3 Joint cement:
 - .1 one-step CSA listed cement for pipe sizes NPS 1½ to NPS 6.
 - .2 IPS primer Type P-70 and Heavy Bodied IPS Cement Type 711 for pipe sizes larger than NPS 6.
 - .3 Volatile Organic Content: maximum 510 g/L.

3 EXECUTION

3.1 Installation General

- .1 Install soil, waste and vent piping in accordance with the requirements of the plumbing code applicable at the project location. Except as otherwise shown, venting of fixtures may use any method permitted in the plumbing code.
- .2 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space.
- .3 Install piping close to building structure to minimize furring. Group piping and run parallel to walls and ceilings.

3.2 Cast Iron Piping

- .1 Install cast iron drainage piping in accordance with Cast Iron Soil Pipe and Fittings (CISPF) Technical Manual.
- .2 Lay buried piping in bedding prepared in accordance with specification section 20 05 25. Support piping on 150 mm (6 in.) thick bed of clean sand, shaped to accommodate hubs and fittings, to line and grade as shown. Backfill with clean sand to 300 mm above top of pipe or to underside of floor slab whichever is less.
- .3 Assemble and tighten mechanical sleeve joints to coupling manufacturers recommended torque value with torque wrench.
- .4 Install cast iron hub-and-spigot joints with neoprene compression gasket and lubrication in accordance with manufacturer requirements.
- .5 Provide thrust restraints consisting of pipe clamps and restraint rods installed across tees, elbows, and blind plugs (cleanouts), for cast iron drainage piping NPS 5 and larger.
- .6 Provide sway braces on all horizontal piping where the hanger length is greater than 450 mm (18 in) measured from the top of the pipe to the structure connection point, as follows:
 - .1 transverse brace at 12 m (40 ft) intervals,
 - .2 longitudinal brace at 24 m (80 ft) intervals,
 - .3 a transverse brace of one pipe section may act as a longitudinal brace for a second pipe section connected perpendicular to the first section, provided the brace is located within 600 mm (24 in) of the connection.
 - .4 for clarity, these braces are required even where seismic restraint is not required.

3.3 Copper Tubing

- .1 Cut copper tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .2 Before assembling solder joints, clean inside of solder fittings and outside of mating pipe with emery paper and coat with flux.
- .3 Solder joints in copper pipe with blow torch or oxy-acetylene flame.

3.4 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper DWV tubing in accordance with Table 1A:

Table 1A: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

- .3 Support horizontal cast iron DWV piping in accordance with Table 1B and as follows;
- .1 at least one pipe support for each length of pipe, located at or within 150 mm (6 in) of each hub or mechanical joint,
 - .2 for mechanical joints, if the pipe length between adjacent fittings is 300 mm (12 in) or less, reduce the support spacing to a maximum of 1000 mm (39 in),
 - .3 where multiple joints occur within a 1000 mm (39 in) developed pipe length;
 - (a) support may be reduced to every other hub or mechanical joint, or
 - (b) where the pipe run is made of multiple fittings connected end-to-end, provide a 1.6 mm (16 ga) galvanized steel half sleeve underneath the pipe and fittings, and support the sleeve with a support at each end of the sleeve.

Table 1B: Horizontal Pipe Support Spacing for Cast Iron DWV Piping		
Pipe Size NPS	Rod Diameter	Maximum Spacing
3	M12 (½ in)	3 m (9.8 ft)
4	M16 (5/8 in)	3 m (9.8 ft)
6 to 12	M20 (¾ in)	3 m (9.8 ft)
15	M25 (1)	3 m (9.8 ft)

- .4 Support vertical pipe and tube risers at the base (bottom) of the riser and as follows:
- .1 for cast iron drain and vent piping,
 - (a) support piping at every floor level with a pipe clamp, arranged so that the pipe clamp is above the pipe section center of gravity,
 - (b) support the pipe below a hub, or support the pipe with a riser fitting for hub-less joints.
 - (c) support the base of a riser at a fitting hub, or for mechanical joints support the riser pipe at a riser fitting,

- (d) for pipe sizes NPS 5 and larger, provide sway braces at the base support to limit movement in both horizontal directions.
- .2 for other piping, support piping at every other floor level with pipe riser clamps,
- .3 for all piping and tubing, do not exceed a vertical spacing of more than 7.5 m (24.5 ft),
- .4 in addition, for cast iron drainage piping provide lateral guides;
 - (a) at the base and top of the pipe riser,
 - (b) and at every 9 m (30 ft) except where the pipe riser clamp is restrained to prevent lateral movement.

3.5 Special Requirements for Urinals

- .1 Use cast iron DWV piping or PVC DWV piping for the following sections of the drainage piping and venting systems for all urinals (do not use copper tube):
 - .1 for the fixture drain between the urinal trap outlet and the connection to another part of the drainage system, other than drainage piping that only serves urinals,
 - .2 for the portion of the vent pipe that vents one or more urinals between the connection to the fixture drain and up to a height not less than the flood level rim of the urinal,
 - .3 for horizontal drains serving only multiple urinals, from the fixture drain and the connection to another part of the drainage system conveying soil or waste from plumbing fixtures other than urinals.

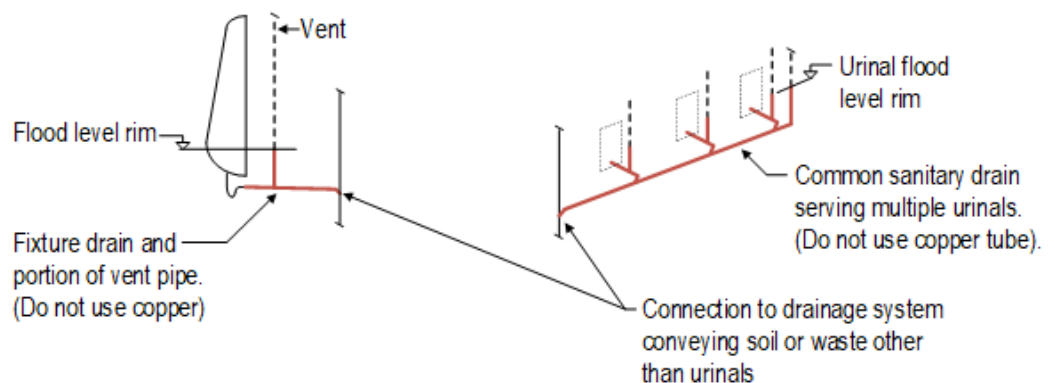


Figure 1: Prohibited use of copper tube

3.6 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SANITARY DRAINS 22 13 19.13

1 GENERAL

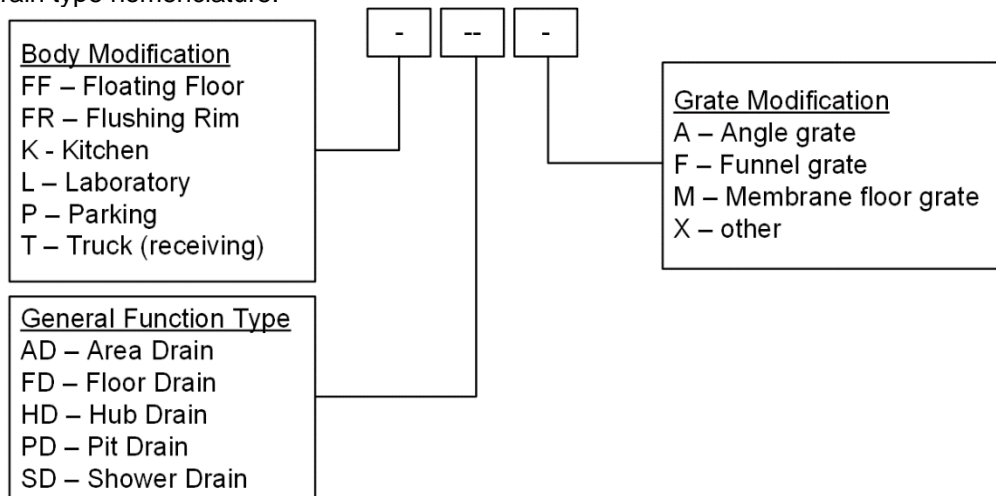
1.1 Scope

- .1 Provide sanitary waste piping accessories including floor drains, area drains and cleanouts.

1.2 Definitions

- .1 The following definitions apply to this specification section.
- .1 **Grate:** the finished exposed element of the floor or area drain which is suitable for heavy loads including vehicle loads.
 - .2 **Sheet waterproof flooring:** includes vinyl sheet or tiles, linoleum sheet or tiles, and rubber sheet or tiles, which have an installed thickness of 6 mm (1/4 in.) or less.
 - .3 **Strainer:** the finished exposed element of the floor or area drain which is suitable for foot traffic only.
 - .4 **Strainer shank:** the strainer supporting element which connects to the drain body. Grate shank has the same meaning.
 - .5 **Tile (floors):** includes ceramic or porcelain tiles and similar materials that are thicker than 6 mm (1/4 in.) including mortar/adhesive bed.
- .2 Load ratings of Light Duty, Medium Duty, Heavy Duty, Extra Heavy Duty and Special Duty: in accordance with CSA B72 / ASME A112.3.1 / ASME A112.6.3.

- .3 Drain type nomenclature:



1.3 Applicable Codes and Standards

- .1 Product standards:
- .1 ASME A112.3.1 Vacuum Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Applications, Above-ground and Below Ground
 - .2 ASME A112.6.3 Floor and Trench Drains
 - .3 ASME A112.36.2M Cleanouts

.4 CSA B79 Commercial and Residential Drains and Cleanouts

1.4 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 Floor Drains (type "FD")

- .1 Floor drains to be listed to CSA B79 and marked in accordance with ASME A112.3.1 (stainless steel floor drains), or ASME A112.6.3 (non-stainless steel floor drains).
- .2 The following requirements apply to all floor drains, combination drains, and hub drains except as otherwise specified.
- .3 Construction:
- .1 application: general purpose floor drains, for floors with or without a sub-floor membrane.
 - .2 loading: Light Duty to CSA B79, for foot traffic,
 - .3 body:
 - (a) coated cast iron with minimum Ø200 mm (8 in.) diameter anchor flange with primary and secondary drainage (seepage) openings,
 - (b) sub-floor membrane clamp,
 - (c) bottom hub outlet pipe connection.
 - (d) NPS ½ NPT trap seal primer connection.
 - (e) No-hub outlet.
 - .4 strainer:
 - (a) adjustable height, nickel bronze or stainless steel strainer secured with stainless steel tamper resistant (Allen key) screws,
 - (b) openings not exceeding 8 mm (5/16 in.) in any direction,
 - (c) round shape for poured monolithic floor finishes,
 - (d) square shape for tiled or similar floor finishes,
 - (e) minimum size: based on location in accordance with the following table.

Drain Pipe Size, NPS	Strainer/Grate Size mm (in.) diameter or square		
	General Purpose, Kitchens	Service Rooms, Wash Down Rooms, Emergency Fixtures	Parking, Loading Docks
2	125 (5)	125 (5)	---
3	175 (7)	200 (8)	---
4	200 (8)	250 (10)	250 (10)
6	250 (10)	250 (10)	250 (10)

- .5 Drain body pipe size as shown on drawings.

Standard of Acceptance

- Watts - fig. FD-100-C-A
- Zurn - fig. Z415 series
- Mifab - fig. F1100-C series
- Jay R. Smith - fig. 2005-C series

2.2 Floor Drain for Finished Membrane Floors (type “FDM”)

- .1 Application: general purpose rooms with sheet or liquid applied waterproof flooring.
- .2 Type FD floor drain and/except as follows:
 - .1 strainer: round, Ø180 mm (7 in.) nickel bronze strainer with surface membrane clamp.

2.3 Funnel Floor Drain (type “FDF-”) – General Purpose

- .1 Application: floors in general purpose spaces and service rooms.
- .2 Type FD floor drains and/except as follows:
 - .1 floor drains other than in service rooms: one piece integral funnel and open-throat strainer, Ø100mm (4 in. dia.) round funnel,
 - .2 floor drains in service rooms: one piece integral funnel and open-throat strainer, 100 mm x 225 mm (4 in. x 9 in.) elliptical funnel.

2.4 Hub Drains (type “HD-”)

- .1 Application: indirect waste hubs for floors in general purpose spaces and service rooms.
- .2 Type FD / FDM / LFD / LFDM floor drain (as applicable) and/except as follows:
 - .1 hub (no strainer):
 - (a) coated cast iron standing hub,
 - (b) minimum Ø100 mm (4 in. dia.) by a minimum height of 50 mm (2 in.) above finished floor level,

2.5 Hub Drain for Fire Protection (type “HDX1”)

- .1 Application: large capacity hopper for fire protection drain lines.
- .2 Type FD floor drain and/except as follows:
 - .1 drain pipe connection size: NPS 6.
 - .2 hub (no strainer):
 - (a) stainless steel hub, NPS 6 x minimum 150 mm (6 in.) long above finished floor level,
 - (b) threaded one end (for connection to floor drain body) and CI OD plain end (for connection to hopper).
 - .3 Fabricated hopper:
 - .1 T304 stainless steel with No. 2B mill finish, all welded construction, and 12 mm x 12 mm angle reinforced top opening.
 - .2 dimensions: 150 mm (6 in.) wide, x 300 mm (12 in.) long x 375 mm (15 in.) high (including sloped bottom),
 - .3 45° sloped bottom to the bottom outlet connection.

- .4 outlet connection: NPS 6, schedule 5 or 10 ASTM A312 stainless steel pipe, 200 mm long.
- .5 brackets at top and bottom to secure hopper to wall or field-installed support frame,
- .6 all welds mechanically ground to remove heat tint,
- .7 No-Hub connector:
 - (a) Shielded transition band-clamp, cast iron to steel IPS.

Standard of Acceptance

- ° Fernco - fig. Proflex 3000 series.

2.6 Floor Drain for Floating Floors (type “FFFD”)

- .1 Application: floors in service rooms with vibration isolation floating floors.
- .2 Double floor drain body assembly with intermediate vibration-isolation connecting pipe:
- .3 Lower body: type FD floor drain and/except as follows:
 - .1 less strainer and strainer shank,
 - .2 full throat NPS 4 coated cast iron or galvanized steel pipe riser, threaded to lower body strainer connection,
 - .3 single arched EPDM or neoprene flexible connector, connected to lower body pipe riser and upper body inlet hub with no-hub stainless steel band clamps.
- .4 Upper body: type FD floor drain and/except as follows:
 - .1 strainer: Ø200 mm (8 in. dia.), round, epoxy coated ductile iron grate.

Standard of Acceptance

- ° Watts - fig. FD-600

2.7 Shower Drains (type “SD”)

- .1 Application: for tiled floor showers and other wet areas with sub-floor membrane,
- .2 Type FD floor drain and/except as follows:
 - .1 Strainer: polished T304 stainless steel strainer and strainer shank.

2.8 Shower Drains with Angle Grate (type “SDA”)

- .1 Application: for tiled floor showers and other wet areas with sub-floor membrane, for mounting at junction of floor and wall.
- .2 Type FD floor drain and/except as follows:
 - .1 grate: nickel bronze angle grate, nominal 108 mm deep x 127 mm wide x 95 mm high (4.25 x 5 x 3.75 in.)

2.9 Area Drains (type “AD”)

- .1 Area drains to be listed to CSA B79 and marked in accordance with ASME A112.3.1 (stainless steel drains), or ASME A112.6.3 (non-stainless steel drains).
- .2 The following specification applies to area drains, except as otherwise specified.
 - .1 loading: Heavy Duty to CSA B79, for automobiles and light trucks.
 - .2 body:

- (a) coated cast iron with minimum Ø200 mm (8 in.) diameter anchor flange with primary and secondary drainage (seepage) openings,
 - (b) sub-floor membrane clamp,
 - (c) outlet size: NPS 3 to NPS 6,
 - (d) drain body pipe size as shown on drawings,
 - (e) stainless steel sediment bucket,
 - (f) No-hub outlet.
- .3 grate:
- (a) ductile iron "no-tip" tractor grate;
 - (b) round: minimum Ø200 mm (8 in. dia.) or larger as shown on drawings.
 - (c) square: minimum 200 x 200 mm (8 x 8 in.) or larger as shown on drawings.
 - (d) grate height above body flange: fixed or adjustable height, for a minimum range of 45 mm to 65 mm (3/4 to 2-1/2 in.).
- .4 drain size as shown on drawings.

Standard of Acceptance

- Watts - fig. FD-3xx series.
- Zurn - fig. Z5xx / Z6xxseries
- Mifab - fig. F3xx / F14xx series
- Jay R. Smith - fig. 22xx series

2.10 Cleanouts

- .1 Listed to CSA B79 and marked in accordance with ASME A112.36.2M.
- .2 In floors:
- .1 line size for NPS 2, NPS 3 and NPS 4, and NPS 4 in larger lines.
 - .2 body: cast iron body with sub-floor membrane clamp, and with gas-tight plug.
 - .3 head - unfinished floor areas including service rooms:
 - (a) coated cast iron frame heavy duty scoriated cast iron round.
 - .4 head - finished floor areas:
 - (a) round, coated cast iron frame and polished nickel bronze adjustable head cover,
 - (b) recessed for tile infill in tiled areas,
 - (c) recessed for carpet infill in carpeted areas,
 - (d) deeply recessed for terrazzo infill in terrazzo finished areas.
 - Watts - fig. C-100 series
 - Zurn - fig. Z-1400 series
 - Mifab - fig. C1100 series
 - Jay R. Smith - fig. 4000 series
- .3 In exposed areas, ceiling spaces and accessible pipe chases,
- .1 cast iron caulking ferrule with neoprene jacket and plug secured to body with cap screws.

3 EXECUTION

3.1 Installation - General

- .1 Install sanitary drainage specialties in accordance with the applicable provincial plumbing code, and the requirements of the local authority having jurisdiction.
- .2 Install sanitary drainage specialties in accordance with the manufacturers installation instructions and as described herein.

3.2 Floor Drains and Area Drains

- .1 For floors constructed with a sub-floor membrane;
 - .1 install bodies flush to top of structural slab, and provide temporary coverings to protect top surface of anchor flange, receiver threads and body openings during concrete pour,
 - .2 after the sub-floor membrane is installed, install the membrane clamp and strainer and set the strainer top to be at the finished floor level or slightly lower,
- .2 For floors constructed as a single concrete pour without a sub-floor membrane, set the body and the strainer to suit the final floor elevation prior to concrete pour. Provide temporary covering of the strainer top surface.
- .3 For all types of floors, place clear pea gravel around the top of the anchor flange to protect the primary and secondary weeping drainage openings from being plugged with concrete or other flooring material.
- .4 Where shown on drawings for a combination floor drain, install a hub of specified type by attaching to the floor drain strainer.

3.3 Hub Drains

- .1 Install hub drain body as described above for floor drains.

3.4 Floating Floors

- .1 Install the lower drain body in the structural floor slab as specified above. During construction of the floating floor, install the hub pipe, flexible connector and upper body and strainer as described above for floor drains.

3.5 Cleanouts

- .1 Install cleanouts at the base of soil and waste stacks, at changes in direction of sanitary drainage piping, at intermediate locations on long runs of piping, and as shown.
- .2 Extend cleanouts flush to wall or up to finished floor above except as follows:
 - .1 clean-outs may be terminated in accessible ceiling spaces except where drawings indicate the clean-out is to be extended up through the floor.
- .3 Install cleanouts located in floors clear of obstructions.

END OF SECTION

PLUMBING FIXTURES

22 42 00

1 GENERAL

1.1 Scope

- .1 Provide plumbing fixtures and trim, and temperature mixing valves for fixtures.
- .2 This specification section does not apply to temperature mixing valves located remote from individual plumbing fixtures, or for process equipment; refer to specification section 22 39 13 *Domestic Water Temperature Mixing Valves*.
- .3 This specification section does not apply to temperature mixing valves for emergency shower and eye-wash stations; refer to specification section 22 45 13 *Emergency Plumbing Fixtures*.

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Barrier-free:** has the same meaning as the applicable building code of the place of the Work, or in its absence, means, when applied to plumbing fixtures and emergency plumbing fixtures, the fixture can be approached, entered, and used by persons with physical or sensory disabilities.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA Z317.1 Special Requirements for Plumbing Installations in Health Care Facilities.
 - .2 CSA Z318.3 Commissioning of Plumbing Systems in Health Care Facilities
- .2 Product standards:
 - .1 ASME A112.6.1 Supports for Off-the-Floor Plumbing Fixtures for Public Use
 - .2 ASSE 1016/ASME A112.1016/CSA B125.16
Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations
 - .3 ASSE 1066 Performance Requirements for Individual Pressure Balancing Valves for Individual Fixture Fittings
 - .4 ASSE 1070 Performance Requirements for Water Temperature Limiting Devices
 - .5 CSA-B45 Series Plumbing Fixtures.
 - .6 CSA-B125 Plumbing Fittings.
 - .7 NSF/ANSI 61 Drinking Water System Components – Health Effects, including Annex G
 - .8 NSF/ANSI 372 Drinking Water System Components – Lead Content
 - .9 UL 1951 Electrical Plumbing Accessories

1.4 Fixture Count and Location

- .1 Determine the number and location of plumbing fixtures from Architectural drawings in the first instance, followed by the mechanical drawings.
- .2 In the event of a conflict as to location of plumbing fixtures between the architectural drawings and the mechanical drawings, the location as shown on the architectural drawings govern.

1.5 Submittals

- .1 Submit product data sheets for materials specified herein. Organize the submission in accordance with the following requirements:
 - .1 make one consolidated submission for all products specified,
 - .2 indicate the fixture type designation for each product on each submittal page,
 - .3 where a fixture type consists of multiple product components, organize the information in a cohesive presentation by fixture type designation,
 - .4 where a data sheet includes multiple figures/options, clearly mark the applicable model number and/or option that is being proposed as meeting the specification requirement.

2 PRODUCTS

2.1 General Requirements - Fixture Quality

- .1 Fixtures and trim of the same type to be the product of one manufacturer.
- .2 Finished surfaces to be clear, smooth and bright, and guaranteed not to craze, discolour or scale.
- .3 Visible parts of faucets, escutcheons, wastes, strainers, traps, shower heads, supplies and stops to be chrome plated.
- .4 Do not include aerators in water supply faucets in healthcare facilities
- .5 Floor mounted water closets fitted with china bolt caps; plastic bolt caps are not acceptable.
- .6 Where fixtures and trim are identified by manufacturers' catalogue designation these references are to establish quality standards not otherwise specified. For the purposes of this section of the specification, fixtures or trim from manufacturers listed below are equally acceptable when conforming to the same level of quality.

Standard of Acceptance

- Eljer
- American Standard
- Crane
- Kohler
- Symmons Valve
- Waltec
- Delta Commercial
- Emco
- Beneke
- Centoco
- Kindred
- Waltec
- Architectural Metals
- Franke
- Whitehall
- Stern Williams

2.2 Water Closet Type "WC-1" – Mental health patient and public – Floor mounted – Rear outlet - Manual

- .1 Bowl: White, ligature resistant, floor mounted, rear outlet, ADA compliant, 16 gage, type 304 stainless steel, seamless welded, with side access panel, all exposed surfaces powder coated white, siphon jet

with elongated bowl, self-draining flushing rim, 4.8 LPF (1.28 GPF), trap with min. 3-1/2" seal and shall pass a 2-1/8" diameter ball, fully enclosed, 1-1/2" NPT flushing inlet connection, white ligature resistant seat cover.

Standard of Acceptance

- Whitehall model# WH2142-ADA-W-2-EGE10 with WH-LRSC-WHITE

- .2 Flush valve, concealed non-hold-open push-button, 16" chrome plated flush valve tube with high pressure vacuum breaker, 6.0 LPF (1.6 GPF), diaphragm with dual filtered fixed bypass, fixed metering bypass, ADA compliant, elbow flush connection with metal button wall actuator.

Standard of Acceptance

- Sloan Prison (600 series) regal 9603-1.6 XL MBFW

- .3 Ligature resistant flush valve access cover, ligature resistant, vandal proof, 304 stainless steel, 16 gage, all exposed stainless steel surfaces powder coated white, vandal resistant fasteners. Provide flush valve model number when ordering for correct size hole punched in the plate.

Standard of Acceptance

- Whitehall WH2898-BLANK (less flush valve and punch)

2.3 Water Closet Type "WC-2" – Mental health – Toilet and Lav combination

- .1 Toilet and Lav combo, ligature resistant, floor mounted back outlet, hemispherical cabinet, type 304 stainless steel, seamless welded, white powder coating, air-control pneumatically operated non hold open flush valve with vacuum breaker. Elongated angled toilet bowl, blowout jet type, 1.28 GPF, self-draining flushing rim, integral contoured seat, 381mm from rim to finished floor, min. 3-1/2" seal passing 2-1/8" diameter ball, fully enclosed. 38mm back inlet connection, back splash mounted faucet with stainless steel push button and chrome plated escutcheons, filler/penal bubbler spout, non-hold open hot and cold water air control metering valve assembly, adjustable from 5-60 seconds. sound-deadened with fire-resistant material. Withstand 5,000 pounds without permanent damage, integral recessed toilet paper holder. Wall sleeve with threaded fasteners. Provide accessible pipe chase for anchor rods, piping, and valves per manufacturer's rough-in drawing.

Standard of Acceptance.

- Acorn LR1418

- .2 Point of use thermostatic mixing valve, bi-metal (bronze, brass, stainless steel), high temperature limit stop set to a maximum 43 °C (109.4 °F), screwdriver adjustment temperature dial with scale: COLD-HOT

Standard of Acceptance

- Sloan – BDT

2.4 Water Closet Type "WC-3" – (Not Used)

2.5 Water Closet Type "WC-4" – Mental health patient and public – Floor mounted – Floor outlet - Manual

- .1 Bowl: White, ligature resistant, floor mounted, rear outlet, ADA compliant, 16 gage, type 304 stainless steel, seamless welded, all exposed surfaces powder coated white, with side access panel, siphon jet with elongated bowl, self-draining flushing rim, 4.8 LPF (1.28 GPF), trap with min. 3-1/2" seal and shall pass a 2-1/8" diameter ball, fully enclosed, 1-1/2" NPT flushing inlet connection, white ligature resistant seat cover.

Standard of Acceptance

- Whitehall model# WH2142-ADA-T-3-EGE10 with WH-LRSC-WHITE

- .2 Flush valve, exposed valve non-hold-open push-button, chrome plated flush valve tube with high pressure vacuum breaker, 4.8 LPF (1.28 GPF), diaphragm with dual filtered fixed bypass, fixed metering bypass, ADA compliant, elbow flush connection. Provide optional flush valve cover with 16 gage, type 304 stainless steel gage, all exposed surfaces powder coated white.

Standard of Acceptance

- WH2802SLPT-ADA

2.6 Lavatory Type “L-1” – Mental health - Bariatric – Hand-free - Hardwired

- .1 Basin: ligature resistant, white, exposed surface powder coated, 1.4mm (16 Ga) Stainless steel basin, countertop, backsplash and side-splash, rated 1,000lbs, wall hung for carrier with concealed arms, ADA compliant, integral D shaped basin with rear overflow, grid strainer, waste piping, and 1-1/2” P-trap, white powder coated s.s. enclosure. With mounting carrier. Sensor operated electronic valve, single temperature, temperature/pressure balancing mixing valve.

Standard of Acceptance

- Whitehall Best-care WH3740BAR-MC-WH3375L-SO-WHST70

- .2 Faucet supplies, chrome plated polished brass, heavy duty angle stops, 10mm (3/8”) I.P.S inlet x 76mm (3”) long rigid horizontal nipples, vandal proof loose keys, escutcheon and flexible copper risers. Provide solid supply tubing where fixtures are not covered with a shroud in clinical spaces.

Standard of Acceptance

- McGuire – LFH165LKN3

- .3 P-trap, chrome plated heavy cast brass with adjustable body, with slip nut, 32mm (1 ¼”) size, antimicrobial protection, with cleanout, box flange and seamless tubular wall bend.

Standard of Acceptance

- McGuire – 8872CBSAN

2.7 Hand Hygiene Sink “HHS-1” – ligature-resistant with Ozonated Water

- .1 Seamless bowl with UVC gel coating protection, overall dimensions of 582 mm x 582 mm x 594 mm (22 7/8 in x 20 15/16 in x 23 1/8 in) with integrated laminar flow faucet with internal electronic sensor providing ozonated water. ODA, and OBC wheelchair accessible and CSA Z8000 compliant. Power shall be hard-wired; provide 24V DC converter (under Div. 26) and coordinate with Div. 26 for installation.

Standard of Acceptance

- Prescient^x SMARTFLO₃ model HHS2321UVDL

- .2 Supplies: 10mm (3/8”) polished supplies with screw driver stops, 305 mm (12”) long braided stainless steel clad rubber flexible risers, lock shield valve.

Standard of Acceptance

- McGuire LFH165LKN12

- .3 Trap: 32mm (1¼”) adjustable “P” trap with cleanout plug, seamless wall bend and escutcheon. All components associated with the drainage and venting of this sink type shall be of material suitable for

corrosive waste in accordance with specification section 22 13 16.19. This includes, but is not limited to, the tailpiece, "P" trap, trap arm and branch piping to the extent required. Coordinate with sink manufacturer to ensure space requirements are met.

- .4 Carrier: Steel uprights with welded feet and integrated rough-in box, including mounting hardware.

Standard of Acceptance

- Franke IWC2104

2.8 Hand Hygiene Sink "HHS-2" – ligature-resistant (Not ozonated water)

- .1 Seamless bowl with UVC gel coating protection, overall dimensions of 582 mm x 582 mm x 594 mm (22 7/8 in x 20 15/16 in x 23 1/8 in) with integrated laminar flow faucet with internal electronic sensor. ODA, and OBC wheelchair accessible and CSA Z8000 compliant. Power shall be hard-wired; provide 24V DC converter (under Div. 26) and coordinate with Div. 26 for installation.

Standard of Acceptance

- Prescient^x SMARTFLO₃ model HHS2321UVDL

- .2 Supplies: 10mm (3/8") polished supplies with screw driver stops, 305 mm (12") long braided stainless steel clad rubber flexible risers, lock shield valve.

Standard of Acceptance

- McGuire LFH165LKN12

- .3 Trap: 32mm (1¼") adjustable "P" trap with cleanout plug, seamless wall bend and escutcheon. All components associated with the drainage and venting of this sink type shall be of material suitable for corrosive waste in accordance with specification section 22 13 16.19. This includes, but is not limited to, the tailpiece, "P" trap, trap arm and branch piping to the extent required. Coordinate with sink manufacturer to ensure space requirements are met.

- .4 Carrier: Steel uprights with welded feet and integrated rough-in box, including mounting hardware.

2.9 Stainless Steel Sink Type "S-1"(single compartment)

- .1 Single compartment, 406 mm x 457 mm x 203 mm (16 in x 18 in x 8 in) bowl, ledge back 18-8 302 stainless steel sink, drilled for 200 mm (8 in) spread fitting and crumb cup strainer and NPS 1½ tailpiece.

Standard of Acceptance

- Franke LBS 6808-1

- .2 200 mm (8 in) fixed centers, concealed deck mounted faucet, 100mm (4") blade handles, polished chrome plated finish, ceramic disc valve cartridge, swivel spout, with 5.7 LPM (1.5 GPM) flow outlet.

Standard of Acceptance

- Chicago 786-GN8FCXKABCP

- .3 NPS 1½ rough brass "P" trap with cleanout

- .4 Rough brass NPS ½ lockshield stop on each supply.

2.10 Stainless Steel Sink Type “S-2” – laundry sink - floor mounted

- .1 Sink: single compartment scullery sink, 16 gauge (1.5mm), type 304 stainless steel, overall size 691mmx691mm, polished to #4 finish, sink compartment sloped to drain with radius coved corners on front and back, rolled rim, stainless steel tubular legs with adjustable feet, waste fitting, certified to ASME A112.19.3-2008 / CSA B45.4-08, center waste location, crumb cup strainer, brass tailpiece.

Standard of Acceptance

- ° Franke Scullery sink SL2424-1

- .2 Faucet: two handle, polished chrome-plated cast brass 203mm faucet, quarter turn ceramic disc cartridge, 203mm centerline rigid/swing gooseneck spout, integral service stops, 102mm vandal-resistant color-coded metal wrist blade handle, 2.2 GPM pressure compensating aerator.

Standard of Acceptance

- ° Zurn Z843C4-XL

- .3 Faucet supplies, chrome plated polished brass, heavy duty angle stops, 10mm (3/8”) I.P.S inlet x 76mm (3”) long rigid horizontal nipples, vandal proof loose keys, escutcheon and flexible copper risers. Provide solid supply tubing where fixtures are not covered with a shroud in clinical spaces.

Standard of Acceptance

- ° McGuire – LFH165LKN3

- .4 P-trap, chrome plated heavy cast brass with adjustable body, with slip nut, 40mm (1 ½”) size, antimicrobial protection, with cleanout, box flange and seamless tubular wall bend,

Standard of Acceptance

- ° McGuire – 8912CBSAN P-TRAP

- .5 All exposed faucet supplies and drains to be insulated with vandal resistant flexible seamless molded closed-cell PVC resin to protect against heat/contusions,

Standard of Acceptance

- ° Prowrap “PW2000”

2.11 Shower Type “SH-1” – Mental health

- .1 Shower base: Terrazzo, non slip roll-in type. 64” x 38” overall dimensions.

Standard of Acceptance

- ° Stern Williams WDA – 3460 64”x38”

- .2 Shower stall by others.

- .3 Shower head and valve: Push button electronic shower, ADA compliant, vandal and ligature resistant, serviceable from the front, 30 degree vandal resistant cast wall mount shower head, 1.5 GPM flow rate, 10” metal control box with recessed, concealed thermostatic mixing valve, hardwired and complete with 120VAC to 24VAC transformer.

Standard of Acceptance

- ° Delta 860T168

- .4 Shower floor drain: ligature resistant 304 stainless steel strainer, vandal resistant screws, adjustable height nickel bronze strainer head, reversible Duco cast iron flashing collar, cast iron body.

Standard of Acceptance

- Whitehall WHFD-5RD-2NH

- .5 P-trap – same material as the connecting pipe drain and provided with a priming connection where showers are located in negatively pressurized rooms.

2.12 Janitor's Mop Sink Type "MS-1"

- .1 915mm x 610mm x 305mm deep (36in x 24 in x 12 in deep) terrazzo floor mounted mop sink composed of pearl grey marble chips and white Portland Cement ground smooth and sealed, one piece stainless steel cast integral on all sides, tiling flange (number of tiling flanges to be confirmed based upon architectural placement of mop sink), 75mm (3") cast brass drain with stainless steel strainer,

Standard of Acceptance

- Stern Williams model SB-302 with "BP" back splash panel (0.9mm (20 Ga) type 304 stainless steel)

- .2 Two handle faucet, chrome plated, 203mm (8") centre-set, solid brass exposed body, ceramic ¼ turn cartridge, unrestricted hose end outlet, 146mm (5 ¾") projection rigid vacuum breaker spout with pail hook, 102mm (4") metal vandal proof wrist-blade handles with blue and red index buttons, wall brace support, 914mm (36") long hose with 20mm (3/4") chrome coupling, stainless steel wall bracket,

Standard of Acceptance

- Chicago Faucets – 445-317-897SRCXKCP (Faucet)
- Chicago Faucets – "T-35" – (Hose and Wall Hook)
- Chicago Faucets – "T-40" (Mop Hanger)

2.13 Washing Machine Wall Box "WB" (laundry)

- .1 Combination 40mm Drain, 12mm hot and cold water unit complete with cover

Standard of Acceptance

- Zurn WM-2961

- .2 Trap: 38mm rough brass P trap with cleanout in wall

Standard of Acceptance

- McGuire 8089

2.14 Thermostatic Mixing Valves – Lavatories, Under-Sink Mount ("TMV")

- .1 General:

- .1 application: temperature mixing valve at an individual lavatories or sinks, for under-basin mounting.
- .2 type: thermal actuated mixing valve,
- .3 listed to ASSE 1070,
- .4 listed to NSF 61+G or NSF 372.

- .2 Performance:

Primary Parameter	Secondary Parameter	Value
Cold water inlet temperature	Range	4 - 20°C (39 - 68°F)
Hot water inlet temperature	Range	49 - 82°C (120 - 180°F)
Maximum Approach Temperature	Hot Inlet to Mixed Temperature	+ 3.8°C (5°F) ΔT
Controlled Temperature Range	High temperature unit	27 to 49°C (80 to 120°F)
Temperature stability, at flow rate range	0 – 0.3 L/s (0 – 5 gpm)	± 1.7°C (±3°F)
	0.3 to 2.5 L/s (5 to 40 gpm)	± 2.8°C (± 5°F)
Maximum Flow Rate	at 100 kPa (15 psi)	0.03 L/s (0.5 gpm)
Minimum Flow Rate	---	0.016 L/s (0.25 gpm)
Maximum Differential Pressure	Between hot and cold supplies	20% of cold water pressure
Minimum design pressure	---	860 kPa at 93°C (125 psi at 200°F)

.3 Construction:

- .1 brass or bronze body, with corrosion resistant internals,
- .2 four port design - cold inlet and outlet, hot inlet, tempered outlet,
- .3 filed-convertible to be suitable for installation as a;
 - (a) dual-outlet for two-handle or single handle faucet, or
 - (b) single-outlet for tempered water to an automatic lavatory faucet,
- .4 thermal actuated movement, with adjustable temperature selection, and maximum temperature limiter,
- .5 tamper resistant setting handle,
- .6 pipe ends: NPS 3/8 compression fittings,
- .7 integral inlet debris screens.

Standard of Acceptance

- Watts (Powers) - fig. LFUSG-B
- Lawler - fig. TMM-1070T

2.15 Sealant Between Fixture and Wall Finish:

- .1 One-part acetoxysilicone sealant
- .2 White or clear colour.
- .3 Formulated with fungicide

Standard of Acceptance

- Tremco - fig. Tremsil 200
- Dow Corning
- GE

3 EXECUTION

3.1 Fixture Installation - General

- .1 Support fixtures level and square and connect with supplies, drains, traps and vents.
- .2 Where a faucet has separate hot and cold water handles, position the hot water handle on the left side of the faucet.
- .3 Where fixtures are located on exterior walls, run the water supplies up through the floor. For other fixture locations, run water supplies in the wall cavity.
- .4 Provide resilient, watertight and gas-tight seals for every joint in a floor flange or between a floor-outlet fixture and the drain.

3.2 Fixture Supports

- .1 Provide plates, brackets, wall carriers, cleats, and supports to secure fixtures in place.
- .2 Fasten wall brackets with bolts attached to double steel supporting plates.
- .3 Bolt fixture to wall through cored holes under lavatory wall flange, using chrome plated carriage bolts with integral washers, and expansion shields.
- .4 Install extra-heavy-duty chair carriers for fixtures not directly supported from floor.
- .5 Conceal vertical supports and baseplates in wall construction.
- .6 Apply sealant bead between wall mounted fixture and finished wall and finish with a smooth concave profile.
- .7 Set floor mounted water closet bowls in mastic, and seal the floor flange with a resilient, watertight and gas-tight flange seal.

3.3 Plumbing Fixture Installation Heights and Clearances

- .1 Install plumbing fixtures at heights as shown on architectural drawings and specifications. Where such information is not provided therein, install fixtures at heights as described in the following table.
 - .1 Mounting heights are in reference to the top of the finished floor level unless otherwise stated.

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
Water Closet	Top of seat	≥ 430 and ≤ 460 (≥ 17 and ≤ 18)	≥ 430 and ≤ 460 (≥ 17 and ≤ 18)
Urinal	Front rim	400 to ≤ 430 (16 to ≤ 16.5) [Note 1]	575 to ≤ 600 (22.5 to ≤ 23.5)
Lavatory	Rim	850 to ≤ 865 (33.5 to ≤ 34)	[850 to ≤ 865 (33.5 to ≤ 34)]

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
Shower	Valve control handle	1150 to ≤ 1200 (45 to ≤ 47)	1150 to ≤ 1200 (45 to ≤ 47)
	Hand-held shower head: Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]
Bathtub	Faucet centerline (above tub rim)	425 to ≤ 450 (16.5 to ≤ 17.5)	425 to ≤ 450 (16.5 to ≤ 17.5)
	Hand-held shower head; Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]

Notes:

[1] Where there are two or more urinals in a washroom, one urinal is to be mounted at this height.

[2] An adjustable hand-held shower head mounted on a vertical shower bar, that can be set at these positions.

[3] If specified.

- .2 Mount manually-operated flushing control for water closets;
 - .1 between 500 and 900 mm above the finished floor, and
 - .2 for barrier-free water closets, located on the transfer side of the water closet.
- .3 Mount manually-operated flushing control for urinals;
 - .1 between 900 and 1100 mm above the finished floor level for barrier-free urinals, and
 - .2 at a height to suit the urinal fixture and flush-control valve for all other urinals.
- .4 For barrier-free lavatories not equipped with a fixture-skirt barrier, arrange piping beneath the lavatory so that the hatched area shown in figure 1 is clear of any obstruction.

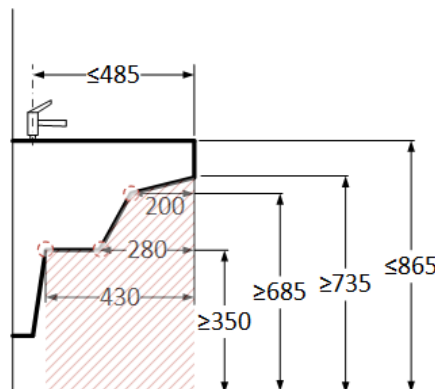


Figure 1: Barrier-Free Lavatory Clearances

3.4 Hand-Held Showers

- .1 Install hand-held shower head hook on independent mounting rail located centered on the shower enclosure wall.

- .1 Do not install shower hooks on grab-bars provided under other Divisions of the Work.

3.5 Thermostatic Mixing Valve Installation

- .1 Install a fixture Thermostatic Mixing Valve at individual faucets where specified as an accessory for the fixture type, or as otherwise shown.
- .2 Provide field installed bass-bodied, in-line spring-loaded check valves on the hot and cold water supplies to each TMV unit, regardless of whether or not the TMV is equipped with integral check valves. For greater certainty, if the TMV unit is supplied with integral check valves they are deemed not to meet this requirement.

3.6 Protection

- .1 Cover plumbing fixtures and trim with plywood, cardboard or heavy paper and kept protected before, during and after installation and until work is completed and accepted.
- .2 Clean fixtures, and trim immediately prior to building completion.

3.7 Start-Up and Testing

- .1 Test, adjust and set high temperature limit stops on fixtures to supply a maximum water temperature, including faucets with integral or remote temperature mixing valves, as follows.

Fixture Type	Occupancy	Temperature Setpoint
Combination tub/shower, Showers	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Faucets	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Group (Sitz Baths)	Healthcare	40°C (105°F)

3.8 Test and Installation Records

- .1 Provide a report of this testing and include:
- .1 fixture reference,
 - .2 measured maximum temperature,
 - .3 date of test(s),
 - .4 signature of person(s) conducting test.
- .2 Submit a copy of each report to the Consultant and Owner for review and acceptance.
- .3 The above tests are subject to a demonstration test audit of up to 10% of the total fixture count to verify compliance. If audit tests are not satisfactory to the Consultant, additional testing and verification will be conducted by the Contractor until such time as a demonstration audit provides satisfactory results to the Consultant.

3.9 Plumbing Fixture Service Requirements

- .1 Unless otherwise shown on the drawings, plumbing fixture service requirements shall be in accordance with Table 1.

Table 1

DRAWING TAG	DESIGNATION	MINIMUM SERVICE CONNECTION SIZE (mm)					QUANTITY OF FIXTURES SERVED BY A SINGLE BRANCH LINE					Remarks
		TYPICAL DRAIN MATERIAL		VENT	COLD WATER	HOT WATER	1	2	3	4	5	
		CAST IRON	COPPER									
WC	Water Closet (Flush Valve)	100	x	40	25	x	25	50	50	65	65	
L	Lavatory	x	32	32	15	15	15	15	20	20	25	
HHS	Hand Hygiene Sink	x	40 per Z8000-11 requirements	32	15	15	15	15	20	20	25	
MS	Mop Sink	80	x	40	20	20	20	x	x	x	x	
SH	Shower	x	50	40	15	15	15	15	20	x	x	
S	Sink	x	40	32	15	15	15	15	20	20	25	
ETP	Electronic trap primer	x	x	x	20	x	x	x	x	x	x	

END OF SECTION

EMERGENCY PLUMBING FIXTURES

22 45 00

1 GENERAL

1.1 Scope

- .1 Provide emergency plumbing fixtures and accessories including drench showers and eye/face wash fixtures.
- .2 Provide thermostatic mixing valves for emergency plumbing fixtures.

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Barrier-free:** has the same meaning as the applicable building code of the place of the Work, or in its absence, means, when applied to plumbing fixtures and emergency plumbing fixtures, the fixture can be approached, entered, and used by persons with physical or sensory disabilities.

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 ANSI Z358.1 Emergency Eyewash and Shower Equipment
 - .2 ASSE 1071 Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
 - .3 NSF/ANSI 61 Drinking Water System Components – Health Effects, including Annex G
 - .4 NSF/ANSI 372 Drinking Water System Components – Lead Content

1.4 Fixture Count

- .1 Determine number and location of emergency plumbing fixtures from mechanical drawings.

1.5 Submittals

- .1 Submit product data sheets for materials specified herein. Organize the submission in accordance with the following requirements:
 - .1 make one consolidated submission for all products specified,
 - .2 indicate the fixture type designation for each product on each submittal page,
 - .3 where a fixture type consists of multiple product components, organize the information in a cohesive presentation by fixture type designation,
 - .4 where a data sheet includes multiple figures/options, clearly mark the applicable model number and/or option that is being proposed as meeting the specification requirement.

2 PRODUCTS

2.1 General Requirements for Emergency Fixtures

- .1 Emergency fixtures listed to ANSI Z358.1.
- .2 Flow rates:
 - .1 Eye/face wash: 11.4 Lpm (3 gpm)
 - .2 Shower: 76 Lpm (20 gpm)

- .3 Hand hose: 1.5 Lpm (0.4 gpm)
- .3 Each emergency fixture provided with signage in accordance with ANSI Z358.1.
- .4 Each emergency fixture provided with a thermostatic mixing valve suitable to its flow rate as specified herein.

2.2 Emergency Eye/Face Wash (type “EW-1”)

- .1 Arrangement: barrier-free, wall mounted.
- .2 Eye/Face wash:
 - .1 spray head(s) with flip-over dust covers, internal flow control and filter,
 - .2 Ø300 mm (12 in. dia.) stainless steel or ABS bowl with NPS 1-1/4 drain,
 - .3 operating valve: NPS 1/2 chrome-plated brass “stay-open” ball valve with PTFE seats and seals, and stainless steel “panic bar” push valve-actuator.
 - .4 offset indirect waste to direct drainage water back to wall.

Standard of Acceptance

- Guardian Equipment - fig. GBF1724
- Bradley - fig. S19224FW
- Haws - fig. 7360BTWC
- Stingray Systems - fig. S2535

- .3 Provide dedicated thermostatic mixing valve “TMV-E” with EW-2

2.3 Emergency Eye/Face Wash – (Blood Draw) (type “EW-2”)

- .1 Arrangement: barrier-free, swing down, sink deck mounted.
- .2 Eye wash:
 - .1 swing-down, two (2) spray heads with flip-over dust covers, internal flow control and filter,
 - .2 operating valve: NPS 1/2 chrome-plated brass, deck-mounted, “stay-open” valve with PTFE seats and seals, and inline strainer;
 - (a) valve opens when eye wash head assembly swings down to the operating position,
 - .3 polished chrome-plated brass tubing,

Standard of Acceptance

- Guardian Equipment - fig. GBF1849
- Bradley - fig. S19-290W
- Haws - fig. 7610

- .3 Provide dedicated thermostatic mixing valve “TMV-E” with EW-2

2.4 Thermostatic Mixing Valves – Emergency Fixtures (“TMV-E”)

- .1 General:
 - .1 application: mixing valve for emergency plumbing fixtures, for eye/face wash, drench shower, and combination units.
 - .2 type: thermal actuated mixing valve,

- .3 listed to ASSE 1071,
- .4 listed to NSF 61+G or NSF 372.
- .2 Performance:

Primary Parameter	Secondary Parameter	Value
Cold water inlet temperature	Range	4 - 20°C (39 - 68°F)
Hot water inlet temperature	Range	49 - 82°C (120 - 180°F)
Controlled outlet temperature	---	29°C (85°F)
Maximum outlet temperature	Limit	32°C (90°F)
Shower Flow Rate	at 210 kPa (30 psi) inlet water pressure	2.1 L/s (33 gpm)
Eyewash/face wash Flow Rate	at 210 kPa (30 psi) inlet water pressure	0.41 L/s (6.5 gpm)
Maximum Differential Pressure	Between hot and cold supplies	5% of cold water pressure
Minimum design pressure	---	860 kPa at 93°C (125 psi at 200°F)

- .3 Construction:
 - .1 brass or bronze body, with corrosion resistant internals,
 - .2 thermal actuated movement, with adjustable temperature selection, and fixed upper temperature limit.
 - .3 fail-safe operation:
 - (a) hot water supply failure: internal bypass allows cold water flow.
 - (b) cold water supply failure: valve closes hot water inlet.
 - .4 tamper resistant setting handle,
 - .5 outlet temperature gauge,
 - .6 pipe ends: NPT to ASME B1.20.1, with unions,
 - .7 integral service stop-valves on inlet piping, inlet check valves and inlet debris screens.

Standard of Acceptance

- Guardian Equipment - fig. G3600 LF, G3700LF
- Bradley - fig. S19-2000, S19-2100
- Haws - fig. 9201E
- Stingray Systems - fig. 84908,
- Leonard - fig. TA-300-LF, TM-600-LF
- Watts - fig. ES150, ETV200
- Lawler - fig. 911E/F, 911

- .4 Cabinet for mixing valves (for finished spaces):

- .1 1.6 mm (16 ga.), T304 stainless steel cabinet with 9.5 mm (3/8 in.) wide return flange for recessed mounting in wall, and hinged door with lock.
- .2 supplied as an accessory part of the TMV.

2.5 Inspection Tags

- .1 Card stock inspection card for recording inspection and test dates.

Standard of Acceptance

- Bradley - fig. SAQ292
- Haws - fig. SP170.

2.6 Signage

- .1 Wall-mounted signs designating location of emergency showers and eyewash stations.
- .2 Size: 355 x 250 mm (14 x 10 in.)
- .3 Material:
 - .1 plastic, suitable for indoor and outdoor locations,
 - .2 exposure temperature: -40 to +80°C (-40 to +176°F), and UV stabilized,
 - .3 chemical and graffiti resistant,
 - .4 rounded corners with four (4) mounting holes.
- .4 Colour: white lettering on green background
- .5 Script: "Emergency Shower and Eyewash" / "Emergency Eyewash Station".

Standard of Acceptance

- Seton

3 EXECUTION

3.1 Emergency Fixture installation

- .1 Install emergency fixtures in accordance with manufacturer's instructions.
- .2 Fasten wall mounted emergency fixtures to concrete block or poured concrete walls with mechanical fasteners as recommended by manufacturer. Where fixtures are to be supported on partition walls, provide a floor mounted fixture carrier with mounting support plate installed inside the partition wall.
- .3 Fasten combination showers and eye/face wash fixtures to the floor.
- .4 Set the top of the bowl for an eye/face wash emergency fixture so that it is not more than 840 mm (33 in.) above the finished floor.
- .5 Set the pull-rod of an emergency shower so that the grasping part of the pull-rod is not more than 1100 mm (43 in.) above the finished floor.
- .6 For exposed eye/face wash fixtures, provide an offset drain back to the wall and down to 100 mm (4 in.) off the floor, terminating with a 45° elbow facing towards the floor drain. Construct this indirect waste of schedule 40 galvanized steel pipe and threaded fittings.
- .7 For type ESWCC fixtures, provide a direct drain connection to the recessed cabinet, with a p-trap and trap primer line and connect to the sanitary drainage system.

3.2 Thermostatic Mixing Valve Installation

- .1 Provide dedicated TMV-E units for each emergency fixture. Locate TMV-E as close as possible and to the side of the emergency fixture.
- .2 In finished spaces, provide TMV-E in a recessed cabinet.
- .3 Provide manual ball valves on the hot and cold water lines serving the emergency fixture.

3.3 Water Supply Piping Installation

- .1 Provide manual, full-ported ball valves with lockshield handle on the hot and cold domestic water supplies to each fixture, located as close as possible to the fixture and upstream of the thermostatic mixing valve. Provide ball valves even if thermostatic mixing valve has fixture stop valves.
 - .1 lock-shield handle to be arranged to allowing locking the valve in the open position.
- .2 Provide in-line, spring-loaded check valves on the hot and cold water supplies to each TMV-E unit, regardless of whether or not the mixing valve has integral check valves. For greater certainty, if the TMV unit is supplied with integral check valves, such check valves are deemed not to meet this requirement.
- .3 Prior to take-over of the Work by the Owner, install nylon tie-wraps to lock the service ball valves in the open position.

3.4 Floor Drains

- .1 Coordinate the location of emergency fixtures with a floor drain at the indicated position. Located the floor drain approximately 300 mm (12 in.) from the wall, and centered under the shower or eye/face wash bowl.

3.5 Signage Installation

- .1 Provide signage adjacent to each emergency shower and/or eyewash station, with top of sign mounted at 2100 mm (6.9 ft.) above floor level, permanently secured to the wall with mechanical fasteners.

3.6 Start-Up and Testing

- .1 Test, adjust and set temperature control on thermostatic mixing valves to supply a maximum water temperature of 29°C (85°F).
- .2 Test, adjust and set high temperature limit stops on thermostatic mixing valves to supply a tempered water not exceeding 32°C (90°F).
- .3 Flow water through each emergency fixture and TMV for at least two (2) minutes. Record the water temperature (as measured at the TMV) at 10 seconds from on-set of flow, at the time to reach the control setpoint, and again at the end of the test period.

3.7 Test and Installation Records

- .1 After completion of testing and at turn-over to the Owner, attach and fill out an inspection tag to each emergency fixture identifying the date of the test and the person who conducting the test.
- .2 Provide a report of this testing and include:
 - .1 fixture reference,
 - .2 measured temperatures,
 - .3 date of test(s),
 - .4 signature of person(s) conducting test.
- .3 Submit a copy of each report to the Consultant and Owner for review and acceptance.

- .4 The above tests are subject to a demonstration test audit of up to 10% of the total fixture count to verify compliance. If audit tests are not satisfactory to the Consultant, additional testing and verification will be conducted by the Contractor until such time as a demonstration audit provides satisfactory results to the Consultant.

END OF SECTION

HVAC PIPING SYSTEMS GENERAL REQUIREMENTS

23 05 01

1 GENERAL

1.1 Scope

- .1 Provide heating and cooling piping systems in accordance with the referenced piping materials, standards, specifications, and piping codes described herein.
- .2 This specification applies to;
 - .1 water based piping systems, including glycol/water mixtures, for building hydronic heating and cooling systems,
 - .2 steam and condensate systems,
 - .3 non-potable water systems for HVAC services, and
 - .4 process heating or cooling systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing.

1.3 Applicable Codes and Standards

- .1 Legislation:
 - .1 Ontario Regulation 220/01 Boiler and Pressure Piping Regulation
- .2 Installation standards and codes (as adopted and amended by the AHJ for pressure vessels):
 - .1 CSA B51 Boiler, pressure vessels, and pressure piping code
 - .2 ASME B31.1 Power Piping
 - .3 ASME B31.3 Process Piping
 - .4 ASME B31.9 Building Services Piping

1.4 Qualified Tradesmen

- .1 Work to be performed by a qualified, licensed and recognized firm with an established reputation in this field, using tradesmen holding applicable certificates of competency as applicable to the work.

1.5 Registration and Inspection

- .1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety for the following pressure piping systems:
 - .1 Steam, including condensate piping, at pressures greater than 100 kPa (15 psig).
 - .2 Service water piping for heating a building, at design temperatures greater than 121°C (250°F) or at design pressures greater than 1100 kPa (160 psig),
 - .3 HVAC water systems (other than building heating water systems), including chilled water and condenser water systems, at design temperatures greater than 65°C (150°F) or design pressures greater than 1717 kPa (250psig).

- .2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

1.6 Design Criteria – General

- .1 Pressure piping design conditions and applicable codes are specified herein. Where different operating and design pressures are shown on drawings, the drawings govern.
- .2 Where a “Class” is indicated on drawings, this refers to Class as defined in the applicable ASME B16 series of product standards. Notwithstanding the maximum allowable pressure-temperature ratings defined for each ASME Class designation, the applicable Class designation by floor level shown on the drawings may identify lower maximum design pressures.
- .3 Where a “Class” is indicated on drawings, this Class designation is applicable to Class rated components other than valves. Refer to valve specification sections for the Minimum Component Pressure Rating for each valve type and selection criteria based on system design pressure.

1.7 Design Criteria - Hot Water Heating Systems

- .1 Piping design and installation code:
 - .1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.
 - .2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.
- .2 System includes but is not limited to;
 - .1 Boilers,
 - .2 Heat exchangers,
 - .3 Pumps,
 - .4 Expansion tanks,
 - .5 Convectors,
 - .6 Radiators,
 - .7 Radiant panels,
 - .8 Finned radiation,
 - .9 Unit heaters,
 - .10 Heating coils,
 - .11 Controls,
 - .12 Water treatment.
- .3 System design criteria:
 - .1 Design temperatures and pressures:

System Type	Supply Temp. °C (°F)	Return Temp. °C (°F)	Design Temp. °C (°F)	Maximum Operating Pressure kPa (psig)	Design Pressure kPa (psig)
Constant temperature heating	77 (170)	66 (150)	96 (205)	900 (125)	1030 (150)
Radiant ceiling panels	77 (170)	66 (150)	96 (205)	900 (125)	1030 (150)

1.8 Design Criteria - Cooling Water Systems

- .1 Piping design and installation code:
 - .1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.
 - .2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.
- .2 System includes but is not limited to;
 - .1 Refrigeration machines,
 - .2 Heat exchangers,
 - .3 Thermal storage tanks,
 - .4 Ice builders,
 - .5 Pumps,
 - .6 Expansion tank,
 - .7 Cooling towers,
 - .8 Indoor condenser water basin,
 - .9 Condenser water filters,
 - .10 Cooling coils,
 - .11 Fan coil units,
 - .12 Server room cooling units,
 - .13 Controls,
 - .14 Water treatment.
- .3 System design criteria:
 - .1 Design temperatures and pressures:

System Type	Supply Temp. °C (°F)	Return Temp. °C (°F)	Design Temp. °C (°F)	Maximum Operating Pressure kPa (psig)	Design Pressure kPa (psig)
Chilled water	6.7 (44)	12.8 (54)	38 (100)	900 (125)	1030 (150)

1.9 Design Criteria - Combined Heating and Cooling Water Systems

- .1 Piping design and installation code:
 - .1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.
 - .2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.
- .2 System includes but is not limited to;
 - .1 Boilers.

- .2 Circulating pumps.
- .3 Heat exchangers.
- .4 Expansion tank.
- .5 Evaporative, Dry cooler.
- .6 Fan coil units
- .7 Induction units.
- .8 Heat pumps
- .9 Controls.
- .10 Water treatment.
- .3 System design criteria:
 - .1 Design temperatures and pressures: SPEC NOTE: Edit the following table. The values for temperature and pressure are examples only.

System Type	Operating Mode	Supply Temp. °C (°F)	Return Temp. °C (°F)	Design Temp. °C (°F)	Maximum Operating Pressure kPa (psig)	Design Pressure kPa (psig)
Exterior Zone Heating and Cooling	Cooling	10 (50)		65 (150)	700 (100)	860 (125)
	Heating	77 (170)				

2 PRODUCTS

2.1 Dielectric Unions

- .1 Construction:
 - .1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.
 - .2 FNPT x Copper sweat connection.
 - .3 Pressure rating; ASME Class 3000 at 121°C (250°F)

Standard of Acceptance

- ° Hart Industrial Unions - fig. D-3136 or Polymer Composite Coating

2.2 Dielectric Flanges

- .1 Construction:
 - .1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.
 - .2 Flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece from contact with the flange.

.3 Minimum MCPR:

- (a) Class 150: 1400 kPa (200 psi) at 121°C (250°F)
- (b) Class 300: 2800 kPa (400 psi) at 121°C (250°F)

Standard of Acceptance

- ° CTS Flange Canada - fig. BF / WBG

2.3 Cam and Groove Fittings

.1 NPS 2 size:

- .1 Brass body cam and groove fittings, male groove end x female NPT end, with camlock female dust cap.

3 EXECUTION

3.1 Pipe Installation General Requirements

- .1 General layout of mains, risers, run-outs and connection details of piping systems are shown.
- .2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.
- .3 Run exposed piping parallel to walls and conserve headroom and space. Group piping wherever practical.
- .4 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading, grooving or welding.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and special fittings such as expansion joints.
- .6 Cap ends during construction to prevent entry of foreign matter.
- .7 Provide bends, expansion loops, hoses or joints to compensate for pipe expansion and contraction.
- .8 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.
 - .1 For steam, gas and vapour piping, provide temporary intermediate supports when hydrostatically piping so that pipe support spans are not greater than that required for liquid piping service.
- .9 Erect piping so that expansion forces, gravity forces and thrust from changes in direction do not stress connections to apparatus.
- .10 Mechanical grooved pipe, couplings, fittings and valves may be used for water and glycol piping systems in place of welded or flanged pipe jointing methods, where operating temperature conditions are in range -30°C through 110°C (-30°F through 230°F).
- .11 Do not use galvanized materials in contact with glycols.
- .12 Refer to piping system specifications for additional requirements.

3.2 Drainage Piping, Drain Valves and Air Vents

- .1 Provide drain valves at low points in water piping systems and in valved run-outs from risers so that system or isolated parts of system can be drained. Locate piping system drain valves as close to the system pipe as possible.
- .2 Provide an additional drain valve at the drain termination point where;

- .1 the drain valve is not accessible from a floor with or without the use of a 2.4 m (8 ft) high ladder, or from an elevated work platform,
- .2 and as otherwise specified herein.
- .3 Provide drain valves on equipment drains, including but not limited to refrigeration equipment, boilers, heat exchangers and water treatment and filtration equipment.
- .4 For copper tube drains, connect copper drain tubing to the outlet side of equipment drain valves or piping system drain valves; do not make connections of copper drain tubes directly to carbon or stainless steel HVAC liquid piping.
- .5 Drain sizes:
 - .1 NPS 2 for large water-filled equipment including refrigeration equipment, boilers, and heat exchangers.
 - .2 NPS ¾ for other equipment drains, including integral or field installed condensate and drip pans.
 - .3 NPS 2 for piping system drains, unless otherwise shown.
- .6 Run large equipment drains to floor trenches unless otherwise shown to terminate in a specific location.
- .7 Run other equipment drains to nearest floor drain unless otherwise shown to terminate in a specific location. Where NPS ¾ drains terminate at a floor drain, provide a funnel of at least 200 mm x 100 mm (8 in x 4 in) on the floor drain cover.
- .8 Install piping system drains as follows;
 - .1 In mechanical service rooms and permanently accessible service spaces, extend drains down along a wall or column and terminate approximately 1000 mm (40 in) above the floor level in the service room, or above the lowest accessible level in a vertical service space.
 - .2 In other service rooms including non-accessible service spaces, electrical rooms, telecom rooms or data rooms, extend drains to a location outside of these service room to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at the termination point.
 - .3 Where piping system drains are located in finished areas above accessible ceilings that are not more than 3 m (10 ft) high, terminate the drains approximately 200 mm (8 in) above the top of the ceiling and provide a drain valve at this termination point.
 - .4 Where piping system drains are located above non-accessible ceilings, or where an accessible ceiling is more than 3 m (10 ft) high, extend the drain tubing to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at this termination point.
- .9 Terminate drain ends with a 45° elbow and a brass body, male-end, cam-and-groove (Camlock) coupling fitting with dust cap. Supply the matching hose-end female connector and turn over to the owner.
- .10 Provide air vents with isolation ball valves at high points to allow effective drainage of the system and to facilitate removal of air from the system.

3.3 Dissimilar Metals Galvanic Isolation

- .1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon steel material. This includes equipment such as coils with copper header connections.
- .2 Dielectric unions or flanges are not required when all of the following conditions are met:
 - .1 the hydronic water treatment program (existing or new) includes a cathodic and/or anodic filming chemistry for mixed metals,

- .2 copper tubing is not used in the piping system, except for the final 1 m (40 in) length connection to terminal equipment and in which the tubing is isolated from the carbon steel piping by a bronze body or carbon steel body valve (no brass) , and
- .3 terminal equipment which contains copper or copper alloy tubing is connected to carbon steel piping with a flexible connector having an internal non-metallic hose.
- .3 For clarity, where copper tubing is installed in a part of a carbon steel piping system, dielectric unions or flanges are required.

3.4 Pressure and Leak Testing - Liquid Service Piping

- .1 This test procedure applies to piping normally containing water, including HVAC and process water and glycol/water mixes, and steam-condensate piping.
- .2 Pressure test liquid piping systems unless otherwise specified in other sections of Division 23.
- .3 Initial pneumatic leak test:
 - .1 Conduct an initial pneumatic leak test to locate and repair major leaks.
 - (a) test pressure for ASME B31.1 systems: 175 kPa (25 psig),
 - (b) test pressure for ASME B31.9 systems: 70 kPa (10 psig).
 - .2 Remove compressed air source and maintain this pressure for the time necessary to inspect for leaks, but not less than 2 hours.
 - .3 Maintain pressure and examine each joint with commercial leak detector solution.

Standard of Acceptance

- Snoop
 - Leak-tec
- .4 Repair leaks where found prior to performing hydrostatic pressure tests.
- .5 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.
- .4 Final hydrostatic pressure test:
 - .1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.
 - .2 Pressure test condensate piping to the same test conditions as the steam system to which they are connected.
 - .3 Fill the system with water and gradually increase the system pressure to 150% of the design pressure and hold for 10 minutes, then reduce pressure to the design pressure.
 - .4 Inspect each pipe joint for leaks.
 - .5 As an alternative to inspection of each joint for leaks, conduct a 24 hour standing pressure test:
 - (a) raise the water pressure to 150% of the design pressure for 10 minutes, then reduce pressure to design pressure,
 - (b) record the test pressure one (1) hour after establishing the system hydrostatic test pressure at the design pressure. Record ambient air temperature at the same time.
 - (c) at the end of the 24 hour standing test period, record the test pressure and ambient air temperature. Make adjustments to the measured end-of-test pressure to account for change in fluid density due to change in ambient air temperature,
 - (d) acceptance criteria: maximum pressure loss over 24 hours not to exceed 1% of test pressure, corrected for ambient temperature,

(e) where acceptance criteria is not met, inspect pipe joints for leaks.

.6 Where leaks are found, repair leaks and retest piping as specified above.

3.5 Pressure Test Report

- .1 Maintain a log of all pressure tests, including locating of where leaks have been repaired. Submit the log to the Consultant for review when requesting prior to substantial completion of the Work. Where a piping system is subject to AHJ inspection, provide evidence of such inspection by means of an AHJ inspection report or name of the AHJ inspector and the date they witnessed the pressure test.

3.6 Piping Material Selection Schedule

- .1 Provide piping material in accordance with schedule Table 1 at the end of this specification section.

Table 1: Piping and Valve Material and Specification by System Type				
Piping System	Abbrev	Pipe Material	Pipe Specification	Valve Specification
Hydronic heating and cooling - closed loop (with or without glycol)	HTS/R HS/R LTS/R GHS/R CHS/R GCS/R RV	Carbon Steel	23 21 13.23	23 05 23.13
		Copper	23 21 13.33	23 05 23.13
Condenser Water - open-loop	CTS/R	Carbon Steel	23 21 13.23	23 05 23.13
		Stainless Steel	23 21 13.26	23 05 23.16
Cooling Tower Overflow and Drain	DR	Galvanized Steel	23 21 13.23	23 05 23.13
Process Chilled Water	PCHS/R	Carbon Steel	23 21 13.23	23 05 23.13
		Stainless Steel	23 21 13.26	23 05 23.16
Process Cooling Water (with city water back-up)	PCWS/R	Stainless Steel	23 21 13.26	23 05 23.16
Snow Melting (buried)	SMHS/R	Polyethylene	23 21 13.37	23 05 23.13
Instrumentation Piping	---	Stainless Steel	23 26 13	
Underground Steam and Condensate Piping	S-xxx PC-xxx GC	Various	23 22 13.13	23 05 23.23

Table 1: Piping and Valve Material and Specification by System Type				
Piping System	Abbrev	Pipe Material	Pipe Specification	Valve Specification
Distribution Steam, Condensate and Boiler Feedwater	S-xxx PC-xxx GC, HD V, RV	Carbon Steel	23 22 13.23	23 05 23.23
Steam Boiler Plant - Steam, Condensate and Feedwater	S-xxx PC-xxx GC, HD BF, BO CBO, HD, V, RV	Carbon Steel	23 22 13.23	23 05 23.26
Clean Steam, Clean Condensate and Clean Feedwater (no chemical treatment)	CS-xxx CPC-xxx CGC CBF BF, BO CBO V, RV	Stainless Steel	23 22 13.26	23 05 23.29
Non-potable make-up water (no pre-treatment, no added chemicals)	NPWH	Copper	23 21 13.33	23 05 23.13
		Stainless Steel (tube or pipe)	22 11 16.16 or 23 21 13.26	23 05 23.16
Water Pre-Treatment for HVAC Services (softened water and dealkalized water)	SWH DALK	Copper	23 21 13.33	23 05 23.13
		Galvanized Steel	23 21 13.23	23 05 23.13
Chemical Feed (chemical water treatment)	CF, CS	Various	23 25 11	
Instrumentation Piping	---	Stainless Steel	23 26 13	
Compressed Air for HVAC Services	CA-P	Galvanized Pipe	23 21 13.23	23 05 23.13
		Stainless Steel Pipe	23 21 13.26	23 05 23.16
		Copper Tube	22 15 13	22 15 16
		Stainless Steel Tube	23 26 16	
Reverse Osmosis water for HVAC Services	ROS/R-H	Stainless Steel Pipe	23 21 13.26	23 05 23.19
		Stainless Steel Tube	23 26 16	

Table 1: Piping and Valve Material and Specification by System Type				
Piping System	Abbrev	Pipe Material	Pipe Specification	Valve Specification
Equipment and piping system drainage for HVAC liquid systems	DR	Galvanized Steel	23 21 13.23	23 05 23.13
		Copper	23 21 13.33	23 05 23.13
Equipment and piping system drains for steam and condensate system.	DR	Same as associated steam and condensate system.		
Brine	BRS/R	PVC	23 21 13.36	

END OF SECTION

GENERAL-DUTY VALVES FOR HVAC WATER PIPING

23 05 23.13

1 GENERAL

1.1 Scope

- .1 Provide valves for general duty service in HVAC water piping systems, including shut-off valves, check valves, and manual balancing valves, for piping systems with a design pressure of 3500 kPa (507 psig) or less and a design temperature of 121°C (250°F) or less.
- .2 This specification applies to hydronic heating and cooling water systems (with or without glycol additives) and other piping systems required to be carbon steel pipe, galvanized steel pipe, and/or copper tubing as specified in section 23 05 01, except as otherwise required for specific duty valve in other specification sections.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section integrates with or refers to the following specification sections:
 - .1 20 05 23 General Requirements for Valves
 - .2 23 05 01 Heating and Cooling Piping Systems

1.3 Submittals

- .1 Refer to section 20 05 23.

1.4 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Where an HVAC liquid piping system is subject to registration as a pressure piping system as identified in specification section 23 05 01, all valves shall have Canadian Registration Numbers in accordance with CSA B51. In the following valve specifications, where the identified model does not have a current CRN, provide a valve of equal or greater performance which has a current CRN from the same manufacturer.
- .3 For the purpose of this article, "current CRN" means a registration which does not expire for at least 12 months from the date of submittal of shop drawings.

2 PRODUCTS

2.1 Ball Valves – bronze/brass body

.1 NPS 2 and under:

- .1 To MSS SP-110, 600 CWP/150 SWP, two-piece bronze or DZR brass body, full port, solid stainless steel or chrome plated bronze ball, PTFE seat and seals.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 Required MCPR: 2300 kPa (335 psig) at 121°C (250°F).
- .4 Solder ends:

Standard of Acceptance

- Kitz - fig. 59, 69AM-LL
- Apollo - fig. 77-200
- Nibco - fig. S-585-70
- Anvil - fig. 171S

.5 NPT threaded ends.

Standard of Acceptance

- Kitz - fig. 58, 68AM-LL
- Apollo - fig. 77-100
- Nibco - fig. T-585-70
- Anvil - fig. 171N

2.2 Ball Valves – carbon steel body

.1 NPS 2 and under:

- .1 To MSS SP-110, 1500 CWP/150 SWP, carbon steel body, regular port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 ISO 5211 mounting pad.
- .4 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).
- .5 Two-piece body style, NPT threaded ends:

Standard of Acceptance

- Apollo - fig. 89-100
- MAS - fig. CSCR-2
- Velan - fig. S-M1102-SSGA

.6 Three-piece body style, NPT threaded ends:

Standard of Acceptance

- Apollo - fig. 83A-140
- Nibco - fig. TM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N
- Velan - fig. S-K1802-SSGA

.7 Three-piece body style, socket weld ends:

Standard of Acceptance

- Apollo - fig. 83A-240
- Nibco - fig. KM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N-SW
- Velan - fig. W-K1802-SSGA

.2 NPS ½ to NPS 4:

- .1 To MSS SP-72, ASME Class rated, carbon steel two-piece split body, full port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals, ASME Class 150 flanged ends.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 ISO 5211 mounting pad.
- .4 Class 150:
 - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 150SCTDZM-N
- Apollo - fig. 88A-200
- Nibco - fig. F-515-CS-F-66-FS
- Velan - fig. SB-150

.5 Class 300:

- (a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCTDZM-N
- Apollo - fig. 88A-900
- Nibco - fig. F-535-CS-F-66-FS
- Velan - fig. SB-300

2.3 Globe Valves

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 150, bronze body, renewable PTFE composition disc, union bonnet, and lockshield handles where shown.
 - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).
 - (b) Solder ends.

Standard of Acceptance

- Kitz - fig. 10
- Crane - fig. 1310 (class 300)
- Jenkins - fig. 106BPJ (class 300)
- Nibco - fig. S-235-Y

- (c) NPT threaded ends.

Standard of Acceptance

- Kitz - fig. 09

- Crane - fig. 7TF
- Jenkins - fig. 106BJ
- Nibco - fig. T-235-Y

- .2 To MSS SP-80, Class 300, bronze body, hardened stainless steel plug, renewable seat and union bonnet, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 17S
- Crane - fig. 382P
- Jenkins - fig. 592J
- Nibco - fig. T-276-AP

- .3 To ASME B16.34, Class 800, forged steel body, bolted bonnet, hard faced disc and seat ring, with NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

Standard of Acceptance

- Crane - fig. B3644XU-T
- Powell - fig. LG08TA58GB
- Beric - fig. 502-T-X-8-A-08

- .2 NPS 2½ and over, flanged:

- .1 To MSS SP-85, Class 125, cast iron body, bronze trim, OS & Y bolted bonnet, bronze disc and seat ring, flat faced flanges,

(a) Required MCPR:

- i) NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- ii) NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 76
- Crane - fig. 351
- Jenkins - fig. 2342J
- Nibco - fig. F-718-B

- .2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, 13% chrome stellite trim, OS & Y, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCJS
- Crane - fig. 151XU
- Jenkins - fig. J1042B2
- Powell - fig. 3031-FC8G
- Beric - fig. 203-RF-EA08-H

2.4 Gate Valves

- .1 NPS 2 and under:

- .1 To MSS SP-80, Class 150 with bronze body, OS&Y rising stem, bronze wedge disc and union or screw-in bonnet, and NPT threaded ends.

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 42
- Crane - fig. 431UB
- Nibco - fig. T-131

- .2 To MSS SP-80, Class 300, bronze body, OS&Y rising stem, copper nickel alloy or stainless-steel trim, solid wedge disc, union bonnet, and NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 37
- Crane - fig. 622E
- Jenkins - fig. 2280UJ
- Nibco - fig. T-174-A

- .3 To ASME B16.34, Class 800, forged steel body, standard port, OS&Y rising stem, solid wedge disc, bolted bonnet, and NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

Standard of Acceptance

- Bonney Forge - fig. HL-11-T
- Crane - fig. B-3604XU-T
- Powell - fig. GA08TA58GB
- Beric - fig. 501-T-X-8-A-02

- .2 NPS 2½ and over, flanged:

- .1 To MSS SP-70, Class 125, cast iron body, OS&Y rising stem, flat faced flanges, bronze trim, and bolted bonnet, and flat-faced flanges.

(a) Required MCPR:

- i) NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- ii) NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 72
- Crane - fig. 465½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

- .2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, OS&Y rising stem, flexible disc, 13% chrome stellite trim, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCLS
- Crane - fig. 33XU-F

- Jenkins - fig. J1010B8F
- Powell - fig. 3003-FC8G
- Beric - fig. 103-RF-AA08-H

2.5 Butterfly Valves – Low Pressure (type “LP”)

.1 NPS 2½ to NPS 24, for flange installation:

- .1 To MSS SP-67, ductile or cast iron flange-less lug body style, flange holes drilled and tapped for ANSI 150 flange pattern.
- .2 Stainless steel shaft, bronze or ductile iron disc with nickel chrome seating edge and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .3 ISO 5211 mounting pad.
- .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .5 Required MCPR:
 - (a) NPS 2 to 12: 1380 kPa (200 psig) at 107°C (225°F).
 - (b) NPS 14 to 24: 1030 kPa (150 psig) at 107°C (225°F).

Standard of Acceptance

- Nibco - fig. LD-2000
- Crane - fig. Center Line RS-200
- Kitz - fig. 6100 series
- DeZurik - fig. BOS-US
- Bray - fig. 31H
- Watts - fig. BF-03-M2
- MAS - fig. D series

.2 NPS 2½ to 12, for grooved end pipe:

- .1 To CSA B242, malleable or ductile iron body with corrosion inhibitor finish, with grooved ends.
- .2 Stainless steel shaft, aluminum-bronze or nickel plated ductile iron or EPDM encapsulated ductile iron disc, and replaceable EPDM resilient seat for bi-directional flow and bubble tight shut-off under system pressure.
- .3 ISO mounting pad.
- .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .5 Required MCPR: 1380 kPa (300 psig) at 107°C (225°F).

Standard of Acceptance

- Victaulic - fig. 761 Vic-300
- Gruvlok - fig. 7700 series

.3 NPS 14 to NPS 24, for grooved end pipe:

- .1 To CSA B242, ductile iron body with corrosion inhibitor finish, with grooved ends.
- .2 Stainless steel shaft, corrosion-inhibitor encapsulated ductile iron disc with offset design, and replaceable EPDM resilient seat for bi-directional flow and bubble tight shut-off under system pressure.
- .3 ISO mounting pad.

- .4 Gear operator.
- .5 Required MCPR: 2065 kPa (300 psig) at 107°C (225°F).

Standard of Acceptance

- Victaulic - fig. AGS Vic-300 W709

2.6 Butterfly Valve - High Pressure (type "HP")

.1 NPS 2½ to NPS 36:

- .1 To MSS SP-68, high pressure offset-disc type, carbon steel lug body with flange bolt holes drilled and tapped, suitable for single flange connection to ASME/ANSI B16.5 flanges (NPS 24 and under) and ASME/ANSI B16.47 Series A flanges (NPS 30 to NPS 48).
- .2 316 or 17-4 stainless steel disc and shaft, PTFE seat, bi-directional bubble tight shut-off under system pressure for dead-end service with flange removed from one side.
- .3 ISO 5211 mounting pad.
- .4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .5 Class 150 valve (NPS 2½ to 36):
 - (a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Nibco - fig. LCS-6822
- Keystone - fig. K-Lok 36
- Nibco SureSeal - fig. G1L
- Bray - fig. McCannalok

.6 Class 300 valve (NPS 2½ to NPS 24)

- (a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Nibco - fig. LCS-7822
- Keystone - fig. K-Lok 37
- Bray - fig. McCannalok

2.7 Inline Silent Check Valves

.1 NPS 2 and under, bronze, threaded:

- .1 To MSS SP-80, Class 125, bronze body, spring-controlled inline style (non flapper), body guided disc, resilient EPDM or PTFE seat or disc; bronze, Inconel or stainless steel spring; with NPT threaded ends.
- .2 Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 36
- Nibco - fig. T-480-Y
- Apollo - fig. CVBB 61-500
- Valmatic - fig. 1400THR

.2 NPS 2 ½ to NPS 12, wafer style:

- .1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, wafer body for installation between flat-faced flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR: 1200 kPa (174 psig) at 65°C (150°F).

Standard of Acceptance

- Dezurik - fig. APCO 300 Series
- Valmatic - fig. 1400A series
- Mueller - fig. 101MAT
- Nibco - fig. W-910

.3 NPS 2 ½ to NPS 24, flanged ends:

- .1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, with Class 125/150 flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR:
 - i) NPS 2-12: 1200 kPa (174 psig) at 65°C (150°F).
 - ii) NPS 14-24: 860 kPa (125 psi) at 65°C (150°F).

Standard of Acceptance

- Dezurik - fig. APCO 600 Series
- Valmatic - fig. 1800 series
- Mueller - fig. 107MAT
- Nibco - fig. F-960

.4 NPS 2 ½ to NPS 24, carbon steel, flanged:

- .1 To MSS SP-126, Class 150 and 300, ASTM A216 WCB carbon steel body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, stainless steel seat, with Class 150 / 300 flanges.
- .2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.
- .3 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Dezurik - fig. APCO 600 Series
- Durabla - fig. GLC
- Mueller - fig. 109MDT

2.8 Swing Check Valves

.1 NPS 2 and under:

.1 To MSS SP-80, Class 125, bronze body, bronze swing disc, screw in cap, regrindable seat.

(a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

(b) Soldered ends

Standard of Acceptance

- Kitz - fig. 23
- Crane - fig. 1342
- Jenkins - fig. 4093J
- Nibco - fig. S-413-B

(c) NPT threaded ends:

Standard of Acceptance

- Kitz - fig. 22
- Crane - fig. 37
- Jenkins - fig. 4037J
- Nibco - fig. T-413-B

.2 To MSS SP-80, Class 300, bronze body, bronze swing disc, screw in cap, regrindable seat, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 19
- Crane - fig. 76E
- Jenkins - fig. 4962J
- Nibco - fig. T-473-B

.2 NPS 2½ to NPS 10, cast iron, flanged

.1 To MSS SP-71, Class 125, cast iron body, flat faced flange, renewable bronze seat ring, bronze disc, bolted cap, with ASME Class 125 flanged ends.

(a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 78
- Crane - fig. 373
- Jenkins - fig. 587J
- Nibco - fig. F-918-B

.3 NPS 2 to NPS 30, carbon steel, flanged:

.1 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, renewable stainless steel seat ring, stainless steel or 13% Cr overlay disc, bolted cap.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCOS
- Crane - fig. 159XU
- Beric - fig. 303-RF-EA08

.4 NPS 2 to NPS 12, for grooved end pipe

- .1 Ductile iron body, ductile iron or bronze disc, nickel seat, EPDM liner, stainless steel spring, with grooved ends.
- .2 Required MCPR: 2000 kPa (290 psig) at 110°C (230°F)

Standard of Acceptance

- Victaulic - fig. 716H/716
- Gruvlok - fig. 7800

2.9 Double Regulating Valves ("DRV")

.1 NPS 3 and under:

- .1 Bronze or DZR brass body, plug type stem with flow measurement ports and tamper-proof setting.
- .2 NPT threaded or soldered ends.
- .3 Required MCPR: 1500 kPa (215 psig) at 121°C (250°F) water temperature.

Standard of Acceptance

- S.A. Armstong - fig. CBV
- Victaulic - fig. 787
- Bell and Gossett - fig. Circuit Setter Plus
- Preso - fig. B-Plus
- Nexus - fig. UltraMB(NL)
- Red White - fig. 9517

.2 NPS 2½ to NPS 12:

- .1 Cast or ductile iron body, copper alloy trim, with flow measurement ports, tamper-proof setting, with groove or Class 250/300 flanges.
- .2 Required MCPR: 1720 kPa (250 psig) at 110°C (230°F)

Standard of Acceptance

- S.A. Armstrong - fig. CBV II
- Victaulic - fig. 788/789
- Preso - fig. B-PLUS
- Nexus- fig. UltraMB
- Red White - fig. 9519

.3 Flow meter for DRVs

- .1 Differential pressure gauge with calibrated charters or direct digital flow meter type.
- .2 Hose and fittings to suit manual double regulating valves.
- .3 In addition to equipment and materials used during start-up and testing, supply one complete set of clean un-used calibrated flow charts or one (1) digital flow meter, to the owner at the completion of the project.

2.10 Plug Valves with Flow Balancing Ports

- .1 NPS 6 to 24, flanged:
 - .1 To MSS SP-78, cast or ductile iron body, lubricated bronze or nickel plated cast iron plug, lubrication assembly, short pattern, with Class 125 flat-face flange ends.
 - .2 Two pressure test ports with pet cocks for differential pressure measurement, and calibrated flow charts.
 - .3 Worm gear operator with memory stop.
 - .4 Class 125:
 - (a) Required MCPR:
 - i) NPS 2-12: 1200 kPa (174 psi) at 121°C (250°F)
 - ii) NPS 14-24: 1000 kPa (145 psi) at 121°C (250°F)
 - Standard of Acceptance*
 - Hattersley - fig. 611
 - DeZurik - fig. Hilton Balancing Valve
- .5 Class 250:
 - (a) Required MCPR:
 - i) NPS 2-12: 2700 kPa (390 psi) at 121°C (250°F)
 - ii) NPS 14-24: 1700 kPa (245 psi) at 121°C (250°F)
 - Standard of Acceptance*
 - Hattersley - fig. 602
 - DeZurik - fig. Hilton Balancing Valve

2.11 Triple Duty Valves

- .1 Combination discharge non-slam check valve, isolation valve and balancing valve ("triple-duty").
- .2 NPS 1-1/4 to NPS 2:
 - .1 Ductile iron body, Class 125, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with NPT threaded ends.
 - .2 Required MCPR: 900 kPa (130 psig) at 110°C (230°F)
 - Standard of Acceptance*
 - S.A. Armstrong - fig. FLO-TREX FTV-T
 - ITT Bell & Gossett
- .3 NPS 2 to NPS 12:
 - .1 Cast or ductile iron body, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with flanged or groove pipe ends.
 - .2 Class 125 required MCPR: 900 kPa (130 psig) at 110°C (230°F)
 - .3 Class 250 required MCPR: 2070 kPa (300 psig) at 110°C (230°F)
 - Standard of Acceptance*
 - S.A. Armstrong - fig. FLO-TREX FTV series
 - ITT Bell & Gossett

3 EXECUTION

3.1 General

- .1 Refer to section 20 05 23 and as required herein.

3.2 Valve Selection Based on Pressure Rating

- .1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:
 - .1 For all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.
 - .2 For clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

3.3 Butterfly valves

- .1 Where butterfly valves are used, provide high pressure HP type butterfly valves as follows:
 - .1 at hot water boiler inlet and outlet connections,
 - .2 at refrigeration equipment evaporator and condenser water inlet and outlet connections,
 - .3 where valves are installed in pipe risers in vertical service shafts,
 - .4 where valves are used to isolate piping service to a building,
 - .5 as required based on valve size and pressure ratings, or
 - .6 at other locations as shown on drawings.
- .2 For butterfly valves with automatic control actuators, select RS or HP type valves as required so that valve torque requirements do not exceed 75% of installed valve actuator torque rating.

3.4 Check Valves

- .1 Provide an inline silent check valve on the pump discharge under any of the following conditions:
 - .1 multi-parallel pump installation,
 - .2 where the pump discharge piping rises to more than 5 m (15 ft) above the pump discharge, and
 - .3 at other locations as shown on drawings.
- .2 Provide an inline silent check valve where a check-valve is shown on drawings other than at a pump discharge.
- .3 Provide swing check or silent check valves at other locations.

End of Section

TESTING ADJUSTING AND BALANCING FOR HVAC

23 05 93.13

1 GENERAL

1.1 Scope

- .1 Test, adjust, and balance ("TAB") air handling systems and hydronic systems installed, modified or extended as part of this work, including:
 - .1 air handling systems, including air handling units and ventilation fans,
 - .2 hydronic systems:
 - (a) heating and cooling equipment and piping systems,
 - (b) boiler feedwater pumps and central condensate receiver transfer pumps,
 - (c) process equipment and liquid piping systems.
- .2 Test existing HVAC systems to record existing operating conditions, at the start of the Work but before any demolition or new construction work is performed.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 22 05 93 Testing Adjusting and Balancing for Plumbing
 - .2 23 05 93.23 Testing, Adjusting and Balancing Supplement for Healthcare
 - .3 23 33 05 Duct Accessories

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Induction units** – means a room air distribution device which uses primary supply air at high pressure to entrain room air into the primary airflow to create a room mixed supply airflow, and may or may not include a cooling or heating coil.
 - .2 **Process cooling (loads)** – means cooling equipment dedicated to a specific process equipment cooling load, and such cooling is not intended for human comfort.
 - .3 **Terminal inlet** – means a room or space return air or exhaust air grille, or other exhaust air inlet connection.
 - .4 **Terminal outlet** - means a room or space supply air grille or diffuser,
 - .5 **Terminal unit** – means a manufactured automatic airflow control-damper unit intended to control airflow to a space or a zone, with or without a reheat coil.
 - (a) **Constant Air Volume terminal unit (CAV)** – means a terminal unit where the airflow control damper is automatically controlled to maintain a constant supply airflow, and space temperature control is by other means.
 - (b) **Exhaust Air Volume terminal unit (EAV)** – means a terminal unit used to control return or exhaust air flow from a room or space, where the automatic control damper is operated to regulate space pressure.
 - (c) **Variable Air Volume terminal unit (VAV)** – means a terminal unit where the airflow control damper is automatically controlled to vary supply airflow to maintain space temperature.

(d) **Limited VAV terminal unit (VAVLM)** – a terminal unit that operates as a VAV at maximum cooling or heating demand under temperature control, and as a CAV at other times to maintain a minimum airflow rate to the room or space. For clarity, the CAV function occurs during normal occupancy times.

.6 **Zone** – means rooms or spaces, or portion thereof, that defines the supply air and return/exhaust air flow being evaluated.

.2 The following abbreviations apply to this section:

- .1 **CAABC** Canadian Associated Air Balance Council
- .2 **NEBB** National Environmental Balancing Bureau

1.4 Applicable Codes and Standards

.1 Installation codes and standards:

- .1 ANSI/ASHRAE 41.2 Standard Methods for Air Velocity and Airflow Measurement
- .2 ANSI/ASHRAE 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
- .3 SMACNA HVAC Systems Testing, Adjusting, & Balancing
- .4 AABC National Standards for Total System Balance
- .5 NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.
- .2 Balancing to be performed under supervision of recognized expert with an established reputation in this field.
- .3 TAB contractor to be a member of CAABC or NEBB.

1.6 Quality Control

- .1 Perform testing and balancing in accordance with procedures as published by ASHRAE, SMACNA, AABC or NEBB except/and as specified herein.

1.7 Accuracy

- .1 Adjust systems until operating values are within the acceptance criteria stated for each system type. Where an acceptance criterion is not stated, balance the system so that measured values are within $\pm 5\%$ of design value.
- .2 Measurement device accuracy:

Measurement	Application	Device	Accuracy
Air Flow	Plenums	Revolving Vane Anemometer, direct reading digital type	$\pm 5.0\%$ of reading over 1 m/s
Air Flow	Ducts	Pitot-tube duct traverse with electronic gauge	$\pm 10.0\%$ of reading over 5 m/s

Measurement	Application	Device	Accuracy
Air Flow	Grilles and Diffusers	Revolving Vane Anemometer, direct reading digital type	$\pm 5.0\%$ of reading
Air Flow	Room air currents, Hoods (0.05 to 3.0 m/s)	Thermal Anemometer	$\pm 10.0\%$ of reading
Liquid Flow	Piping	Installed meter	As per meter rating
Liquid Flow	Equipment	Differential Pressure and equipment data	See below
Temperature	Air, Liquids	Digital Electronic Thermometer	$\pm 0.2^{\circ}\text{C}$ over 0 to $+40^{\circ}\text{C}$
Temperature	Air, Liquid	Digital Electronic Thermometer	$\pm 0.4^{\circ}\text{C}$ $< 0^{\circ}\text{C}$ and $> +40^{\circ}\text{C}$
Relative Humidity	Air	Digital Electronic Humidity Sensor	$\pm 1.5\%\text{RH}$ over 0 to 90%RH range
Pressure	Air	Magnahelic	$\pm 2.0\%$ of reading
Pressure	Liquid, Gas, Steam	Bourbon type	$\pm 1.0\%$ of reading
RPM	Motor, fans	Chronometer tachometer	$\pm 1.0\%$ of reading
Voltage	All	Portable	$\pm 2.5\%$ of reading
Current	All	Portable clamp-on ammeter	$\pm 2.5\%$ of reading

1.8 Audit Verification

- .1 After review of the draft TAB report by Consultant, the Consultant may at their sole discretion require re-measurement of TAB results on an audit sample rate of 30 percent of all measured equipment, at no cost extra to the Contract Price or change to project schedule.
- .2 If audited results indicate a variance of more than 10% between the original reported value and the audit measured value for a piece of equipment, re-balance the audited device. If this excessive variance condition occurs at more than 25% of the number of audited equipment sample, re-balance the entire affected system at no cost extra to the Contract Price or change to project schedule.

1.9 Preparatory Work

- .1 Develop a TAB work plan to communicate TAB requirements to other trades:
 - .1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.
 - .2 Prior to commencement of piping and ductwork installation, mark-up Consultant's Contract Drawings or contractor's fabrication drawings to identify locations where balancing damper and valve devices, temperature wells, pipe pressure gauges and pressure test plugs are to be installed. Provide a copy to the trade contractor responsible for installation of balancing devices. Make a copy available for review when requested by Consultant.
- .2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated. Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, balancing valves, balancing dampers and splitter dampers, and access doors.

- .3 TAB measurements to commence when building is “closed in” and work is sufficiently advanced including;
 - .1 installation of ceilings, doors and windows is completed,
 - .2 application of sealing, caulking, and weather stripping is completed,
 - .3 allowing normal operation of mechanical systems.

1.10 Pre-Construction Air and Water Measurement Audit

- .1 Conduct an HVAC air and water audit of existing HVAC systems prior to commencement of demolition or new construction work.
- .2 Measure existing air conditions for the systems affected by the Work:
 - .1 measure airflow, pressure, and temperature at main supply and return ducts on each floor where Work is to be performed,
 - .2 for fans, measure airflow, motor amps, motor HP rating, motor volts, inlet and discharge static pressure, sheave position,
 - .3 for air handling unit systems including air conditioning units, measure total airflow, outdoor airflow, return airflow; outdoor, return air and supply air temperatures.
- .3 Measure existing service water conditions for the systems affected by the Work:
 - .1 measure water flow at on each floor where Work is to be performed,
 - .2 for each source equipment including chillers and boilers, measure inlet and outlet water pressure, inlet and outlet water temperature, water flow rates,
 - .3 for each pump, measure water flow rate, inlet and outlet static pressures, motor amps, motor rated HP, motor voltage.
- .4 Submit a report to Consultant to record all as-found measured values.

1.11 Measurement Parameters

- .1 Reporting units of measure:

Parameter	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Volume	litre	L
Volume flow rate	Litres per second	L/s
Time	seconds	s
Temperature	Celsius	°C
Pressure	pascal	Pa (air)
	kilopascal	kPa (liquid, vapour, compressed gas)
Pump Head	metre	m
Pump Pressure	kilopascals	kPa

Parameter	Unit	Abbreviation
Fan pressure	pascal	Pa
Mass flow rate	kg per second	kg/s
Heat flow rate	kilowatts	kW
Cooling flow rate	Kilowatts cooling	kWc
Electrical Power	kilowatts	kW
Voltage	Volts	V
Electrical Current	amps	A
Rotation speed	Rotations per minute	RPM
Vibration	Cycles per second	CPS or Hz

2 PRODUCTS

2.1 Ductwork Probe Test Plugs

- .1 Conform to Specification section 23 33 05.

3 EXECUTION - AIR MOVING SYSTEMS

3.1 Measurement Parameters

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
 - .1 Air flow parameters;
 - (a) air velocity,
 - (b) flow cross sectional area,
 - (c) static pressure,
 - (d) velocity pressure.
 - .2 Temperature parameters;
 - (a) wet bulb,
 - (b) dry bulb.
 - .3 Pressure parameters;
 - (a) gauge pressure,
 - .4 Equipment parameters;
 - (a) rotational speed (rpm),
 - (b) electrical power, kW
 - (c) voltage. V
 - (d) current, A,
- .2 Measurement are required at and around equipment to establish air side performance of;
 - .1 fans,
 - .2 coils,

- .3 filters,
- .4 dampers - outdoor, return, recirculating, and relief,
- .5 humidifiers.
- .6 terminal units.
- .3 Measurement are required to characterize system performance;
 - .1 at main ducts,
 - .2 at submain ducts,
 - .3 at branch ducts.
 - .4 at each supply air outlet diffuser or grille, and exhaust and return air inlet grille,
 - .5 in each thermostatically controlled zone.

3.2 General Requirements

- .1 Balance systems so that fans operate at lowest possible speed and static pressure consistent with delivery of specified air quantity at most remote terminal point.
- .2 Measure air quantities at each exhaust system inlet and supply system outlet.
- .3 Balance supply fans and associated return fans with their respective outdoor air dampers and exhaust air damper at their minimum airflow position.
- .4 Be responsible for supply and installation of ductwork test plugs.

3.3 Setting Grill and Diffuser Airflow Patterns

- .1 Adjust the throw and pattern at each supply outlet as shown on drawings. Where a specific pattern is not shown, set the supply outlet grills and diffusers in accordance with the following;
 - .1 for rectangular and circular cone diffusers, set for a uniform 360° dispersion,
 - .2 for rectangular perforated-plate diffusers, set the flow pattern plates for four-direction horizontal dispersion,
 - .3 for rectangular wall-mount grilles with horizontal front blades, set the blades at an approximate 15° upward facing angle,
 - .4 for linear diffusers at exterior windows or walls, set the flow pattern blades for a downward flow towards the floor and parallel to the windows or wall,
 - .5 for linear diffusers in interior spaces within 300 mm (12 in.) of a wall, set the flow pattern blades for horizontal dispersion away from the wall,
 - .6 for linear diffusers in interior spaces other than close to a wall, set the flow pattern blades for bi-directional horizontal dispersion,
 - .7 for light-troffer diffusers, set the flow pattern blades for horizontal dispersion away from the light fixture.

3.4 Use of Terminal Unit Flow Stations for Balancing Purposes

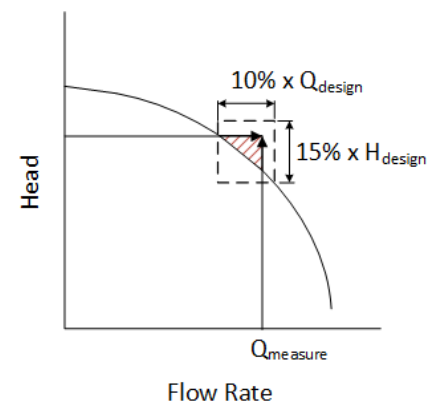
- .1 Where terminal units are equipped with integral air flow stations, do not use these air velocity stations as a proxy for manual duct traverse measurements of the zone airflow.

3.5 Transient Operating Conditions Preparation

- .1 Set-up supply fans with sufficient speed to deliver design air flow when filters are loaded to manufacturers recommended maximum pressure drop (dirty filter condition) and condensing coil air-pressure drop is at its wet coil condition;
- .2 Temporarily block portions of filter banks to achieve maximum pressure drop at design air flow, to simulate dirty filters.
 - .1 only apply blanking material to the highest MERV rated filter in the air handling unit. If there is more than one filter bank, test the remaining filter banks in their clean condition.
- .3 Temporarily block portions of cooling coils to achieve rated wet coil pressure drop at design air flow, to simulate summer condensing operation.
- .4 Uniformly distribute blocking media across filter face and coil face to minimize disruption to overall airflow pattern through the filter and coil bank.
- .5 Remove blanking material at completion of system TAB.

3.6 Fan Performance Assessment

- .1 Obtain the measured duct leakage for each system prior to balancing the duct systems and record in the TAB report. An additional 5% of terminal outlet design airflow rates may be included for balancing effects on the fan delivered airflow rate.
- .2 Measure air quantity by taking anemometer traverses across a coil or at a filter bank, or by pitot tube traverse in a straight section of duct at fan suction or discharge.
- .3 Measure static pressure difference between fan inlet and discharge, motor amperage and fan rotation speed. Determine motor input power from a curve showing power output as a function of motor amperage for the particular motor.
- .4 Plot results of measurements on fan characteristic curve supplied by fan manufacturer; the measured air volume, static pressure and fan speed lines should form a triangle enclosed by a rectangle having a dimension of not more than 15% of the design static pressure by a dimension of not more than 10% of the design airflow rate. Input power taken from the fan characteristic should be within 10% of the power determined from the motor amperage readings.
- .5 If required precision is not obtained, repeat measurements. If subsequent testing shows that the required precision is unobtainable, then fan manufacturer is to submit written report explaining actual fan performance and provide new characteristic curve showing actual performance for fan "as installed".
- .6 Measure static pressure loss across cooling coils, heating coils and individual filter banks and tabulate readings with manufacturers published pressure loss figures for the actual measured air volume.



3.7 Branch Air Quantity Measurement Procedure

- .1 Determine branch air quantities using pitot tube traverses in accordance with the procedures defined in ASHRAE 111 and ANSI/ASHRAE 41.2.
- .2 Take measurements at each riser as it is connected to fan discharge or suction header and at each floor where branches are taken from the riser. Repeat measurement until sum of branch air quantities is within 10% of fan delivery.

3.8 Constant Volume System Balancing Procedure

- .1 Application:
 - .1 single zone systems with constant airflow,
 - .2 constant volume systems using CAV terminal units,
 - .3 constant volume systems with terminal reheat coils,
 - .4 exhaust systems, constant airflow,
- .2 Where a system has CAV units, or a system has a mixture of no units and CAV units, set the CAV units for 100% design airflow at all times.
- .3 Where a system has EAV units, set EAV units to 100% design airflow prior to balancing the supply air system.
- .4 First step - balance the branch ducts:
 - .1 open all supply air terminal outlets and return/exhaust air terminal inlets to 100% full open,
 - .2 starting with the submain duct closest to the fan or the submain duct that has the highest percentage airflow, measure and balance airflow on each branch duct off that submain duct,
 - .3 repeat on other submain ducts in descending order of percent of total airflow, until all branch ducts are balanced,
 - .4 verify supply and return fans are delivering 100% design airflow.
 - .5 acceptance criteria:
 - (a) branch airflow measurement: $\pm 5\%$ of design flow.
 - (b) fan airflow measurement: $\pm 5\%$ of design flow.
- .5 Second step - balance airflows at zones:
 - .1 starting at the most remote zone, balance terminal outlets and inlets using duct balancing dampers ahead of the outlet or inlet device. Only use any integral balancing device in the terminal outlet or inlet to adjust the final airflow rate by not more than 10% of design flow,
 - .2 for supply grilles and diffusers, adjust airflow pattern controllers to prevent airflow impinging on adjacent walls.
- .6 Acceptance criteria:
 - .1 total of terminal outlets/inlets airflow measurement in each zone: $\pm 10\%$ of design flow.

3.9 VAV System Balancing Procedure

- .1 Applicable systems:
 - .1 variable volume supply air systems using VAV terminal units, with minimum flowrate setpoint set equal to zero airflow.
- .2 Obtain from Consultant the expected diversity value, or determine the percent diversity by dividing the fan design air flow rate by the sum of all supply outlets or return/exhaust inlet flow rates as applicable.
- .3 First step: balance the branch ducts:
 - .1 set all interior terminal units to 100% design flow rate (full cooling), and proportionally adjust all perimeter terminal units so that the design fan air flow rate is achieved at the supply and return fans,
 - .2 starting with the submain duct closest to the fan or the submain duct that has the highest percentage airflow, measure and balance airflow on each branch duct off that submain duct/

- .3 repeat on other submain ducts in descending order of percent of total airflow, until all branch ducts are balanced.
- .4 verify supply and return fans are delivering 100% design airflow.
- .5 acceptance criteria:
 - (a) branch airflow measurement: $\pm 5\%$ of design flow.
 - (b) fan airflow measurement: $\pm 5\%$ of design flow.
- .4 Second step: balance airflows at terminal units:
 - .1 open sufficient VAV terminal units having the highest airflow demand to 100% maximum design flow rates, and close a random selection of other terminal units, equally distributed throughout the system, to obtain the design fan flow rates.
 - .2 set system to operate with 100% return air, set room thermostats at design indoor temperature, set fan discharge temperature at design point.
 - .3 set thermostat in the most remote zone (the "first zone") to full cooling, open the duct balancing damper serving the terminal unit to full open, and adjust the fan static pressure controller until required airflow is delivered by the terminal unit;
 - (a) reset the first zone room thermostat to full heating and check performance of terminal unit controller,
 - (b) after completion of balancing, reset zone thermostat to design temperature and balance next terminal unit.
 - .4 on the next terminal unit, set thermostat to full cooling, adjust the duct balancing damper serving the terminal unit to obtain the design airflow rate for that unit such that the terminal unit control damper is not less than 60% open at design airflow rate;
 - (a) do not use the terminal unit controller to consume excess air pressure.
 - (b) if zone air quantity is less than design, increase fan static pressure controller setting to achieve design air quantity and rebalance previously checked zones.
 - (c) reset thermostat to design temperature and repeat procedure for remaining terminal boxes,
 - .5 if the required airflow adjustment to any terminal unit airflow rate is $\pm 5\%$ or less to meet the acceptance criteria for terminal units, then no adjustment is required to nearby terminal units, If the adjustment is greater than 5%, check nearby terminal units and adjust as require to obtain airflow rate at the acceptance criteria.
- .5 Acceptance criteria:
 - .1 VAV terminal unit airflow measurement: $\pm 10\%$ of design flow.

3.10 VAVLM Balancing Procedure

- .1 Applicable systems:
 - .1 partial variable volume supply air systems using VAVLM terminal units, where the terminal unit's minimum airflow rate setpoint is between zero and the design maximum flow rate setpoint, but is not zero.
- .2 Where a system has EAV units, set EAV units to 100% design airflow prior to balancing the supply air system.
- .3 Same procedure as for all VAV system specified previously except as follows:
 - .1 where a VAVLM has minimum airflow setpoint = maximum airflow setpoint, set these units to 100% design airflow at all times,

- .2 balance the constant volume VAVLM units first, then balance the modulating VAVLM units are per the procedure described above.
- .4 After balancing the zone supply terminal units at maximum cooling, adjust the space temperature setpoint to full heating, and verify that modulating VAVLM reduces the airflow to its design minimum airflow setpoint.
- .5 Acceptance criteria for VAVLM terminal unit airflow rates:
 - .1 healthcare facilities: $\pm 5\%$ of design flow.
 - .2 laboratory facilities: $\pm 5\%$ of design flow.
 - .3 art galleries: $\pm 5\%$ of design flow.
 - .4 other facilities: $\pm 10\%$ of design flow.

3.11 Terminal Unit Balancing Procedure

- .1 For spaces or zones with ducted return, close the doors to the space and then first balance return/exhaust terminal inlets to design flow rates.
- .2 Balance terminal outlets and inlets downstream of terminal units after the associated terminal units and supply, return and exhaust fans have been balanced.
- .3 Set system to operate with 100% return air, set zone thermostats at indoor design temperature and set fan discharge temperature at design value. Where a ducted return system is used, open any doors to adjacent spaces in the room under test.
- .4 Set thermostat in each zone being balanced to full cooling. Verify terminal unit airflow is supplying 100% design airflow.
- .5 Adjust each terminal outlet grille or diffuser to design airflow rates.
- .6 Repeat for all other terminal unit zones.
- .7 After all terminal unit zones are balanced, check fan performance and adjust fan static pressure controller as required to operate the fans at the minimum static pressure required to achieve terminal unit design airflow rates.

3.12 Outdoor Air Adjustment Procedure

- .1 After balancing of supply fan, return fan, and related exhaust fans systems, adjust the outdoor air dampers position to obtain minimum design fresh air quantity.
- .2 Measure outdoor air values by duct traverse reading across outdoor air intake, recirculation duct, and exhaust air duct.
 - .1 Where there is insufficient duct length to provide reliable traverse readings, determination of outdoor air flow rate may be estimated based on a mixed airflow coil or filter bank traverse and measurement of outdoor air, return air, and mixed air temperature, provided the temperature differential between outdoor and return air is at least 11°C (20°F).
 - .2 Where neither of the above methods can be used, a temporary outdoor air minimum damper position may be set by measuring the pressure drop across the outdoor air damper and estimating the airflow rate based on damper manufacturer pressure drop data. Once outdoor conditions are available, remeasure and reset the outdoor air damper minimum position based on mixed air temperature conditions.
 - .3 Where temperature is used to estimate the balanced minimum outdoor air flow rate, include calculations of same in the balancing report.

- .3 After the minimum outdoor air flow rate and damper position have been adjusted, operate the air handling system at 100% outdoor air. Check that supply fan and return fan are operating within 5% of their airflow rate at minimum outdoor air condition.
 - .1 If the supply or return air flow rates at 100% outdoor air exceed their respective airflow rates at minimum outdoor air condition by more than 5%, adjust the maximum outdoor and exhaust air dampers to reduce their percent opening until the airflow variance is less than 5%.
 - .2 If the supply or return airflow rates at 100% outdoor air is less than their respective airflow rates at minimum outdoor air condition by more than 5%;
 - (a) reduce the minimum outdoor damper open position and return damper open position, and increase fan static pressure controller setpoint to re-establish minimum outdoor air flow rate,
 - (b) recheck the supply or return fan airflow rates at 100% outdoor air damper position.
 - (c) repeat above adjustment procedure until supply or return air fan airflow rates at 100% outdoor air is within 5% of their respective airflow rates at the minimum outdoor air damper position.

3.13 VFD Setpoint and Fan-Motor Sheave Change

- .1 For fans with VFD motor controllers, at completion of system balancing, if the maximum VFD control point is more than 15% below the motor rated operating speed (< 50 Hz on a 60 Hz rated motor frequency), replace the drive sheaves and pulleys so that the motor is operating within 10% of motor rated speed at full load operating conditions,

4 EXECUTION - HYDRONIC SYSTEMS

4.1 Measurement Parameters

- .1 The following measurement parameters identify the minimum requirements for inclusion in the TAB process:
 - .1 volume flow rate,
 - .2 temperature,
 - .3 pressure (gauge),
 - .4 equipment related;
 - (a) rotational speed (rpm),
 - (b) electrical power, kW
 - (c) voltage, V
 - (d) current, A,
- .2 Measurement are required at and around equipment to establish fluid side performance of;
 - .1 heat exchangers (primary and secondary sides),
 - .2 coils,
 - .3 refrigeration equipment (water side),
 - .4 boilers,
 - .5 pumps,
 - .6 PRVs,
 - .7 makeup (water) systems,
 - .8 domestic hot water heaters,
 - .9 humidifiers.

- .3 Measurement are required to characterize system performance;
 - .1 at floor branch connections (where measurement devices are installed),

4.2 General Requirements

- .1 Use calibrated venturi tubes, orifices or other metered fittings and pressure gauges in conjunction with permanent and portable type flow meters to determine flow rates for system balance.
- .2 Effect system balancing with automatic control valves open to heat transfer elements and bypasses closed.
- .3 Check and clean strainers prior to balancing.
- .4 Check expansion tanks are not waterlogged, and record expansion tank pressure before and after system pumps are turned On, and again when the system is at design operating temperatures.
- .5 Base flow balance on (in order of preference):
 - .1 double regulating valves, or globe valves associated with flow measuring elements (flow meters),
 - .2 temporary non-invasive flow meters,
 - .3 differential pressure measurement across heat transfer elements, with flowrate determined from manufacturer's literature, or
 - .4 temperature difference across various heat transfer elements in the system where flow metering devices are not installed. This method may only be used at design heat transfer conditions and at least one flow rate is known.
- .6 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing.
- .7 Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .8 Adjust water distribution systems by means of double regulating valves, globe valves, balancing cocks, valves and fittings. Do not use shut-off valves for balancing unless indexed.
 - .1 Butterfly valves on discharge side of pumps may be used if they are one trade size smaller than system pipe size. Include Cv values and flow vs valve position curve with balancing report.

4.3 Variable Flow Rate Balancing Procedure

- .1 Obtain from Consultant the expected diversity value, or determine the percent diversity by dividing the pump design flow rate by the sum of all connected loads.
- .2 Where available pump capacity is less than total flow requirements of individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.
- .3 First step - Balance pipe riser floor branches:
 - .1 applies where floor-branch riser connections are provided with measurable pipe balancing devices,
 - .2 open all load control valves to 100% open,
 - .3 run all system pumps, and balance the most remote floor-branch balancing device; floor-branch balancing devices on other floors may be partially closed. Adjust pump static pressure controller to supply the minimum required pressure to obtain required flow rate at the floor.
 - .4 repeat with other floors progressing towards the floor closest to the pump.
 - .5 acceptance criteria: $\pm 5\%$ of total design flow rate of the branch.
- .4 Second step – Balance loads:

- .1 balance the most remote load from the branch balancing valve, with other loads on the same branch throttled at the estimated system diversity.
- .2 repeat with other load valves on the same branch moving towards the floor balancing device.
- .3 Acceptance criteria: $\pm 10\%$ of design flow rate at each load.

4.4 Pressure-Independent Control Valves Balancing Procedure

- .1 Where all load connections on a system are equipped with a pressure-independent balancing valve, the preceding balancing procedure may be modified as follows:
 - .1 open all control valves to 100% open and adjust pump speed or balancing valve to limit pump discharge to not exceed the maximum design flow rate,
 - .2 starting at the closest valve to the pump, set the pressure-independent control valve to the required flow rate,
 - .3 proceed with succeeding valves, moving towards away from the pump(s) towards the most remote-control valve,
 - .4 if necessary, manually reduce flow rates through some control valves to obtain sufficient flow for the most hydraulically remote pressure-independent valves,
 - .5 After the pressure-independent control valves are set, reduce pump speed or adjust pump discharge balancing valve to provide the lowest differential pressure to achieve the required total design flow rate.

5 EXECUTION - EQUIPMENT TESTING

5.1 Performance Data

- .1 Submit the following data as a minimum. If contractor's standard forms provide for additional data, also submit such additional data.
- .2 Some equipment tests may need to be performed during the alternate season testing.
- .3 Include nameplate data and as-tested results.
- .4 Water chillers:
 - .1 manufacturer and model,
 - .2 refrigerant type and weight,
 - .3 cooling rating (refrigeration tons),
 - .4 condenser:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) flow rate (minimum, maximum),
 - (d) pressure rating (MAWP),
 - .5 evaporator:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) flow rate (minimum, maximum),
 - (d) pressure rating (MAWP),
- .6 motor real power (kW),

- .7 motor apparent power (kVA) or power factor (PF).
- .5 Hydronic Heating Equipment (Boilers, Heaters, etc.):
 - .1 manufacturer and model,
 - .2 heat output rating (kW),
 - .3 electric power input rating (kW),
 - .4 gas and fuel oil input flow rating,
 - .5 gas and fuel oil input pressure rating (minimum, maximum),
 - .6 gas pressure regulator inlet and outlet pressure,
 - .7 heat performance:
 - (a) entering and leaving water temperature,
 - (b) entering and leaving water pressure,
 - (c) liquid flow rate (minimum, maximum),
 - (d) steam flow rate and pressure,
 - (e) pressure rating (MAWP),
 - .8 pressure relief valve rating (pressure setpoint, heat rating, steam rating).
 - .9 combustion efficiency test at maximum rated capacity; including flue gas analysis corrected to 3% O₂, for fuel input ratings exceeding 2930 kW (10 MMBtu/h),
 - .10 thermal efficiency test at maximum rated capacity, based on ASME PTC 4 for steam boilers with fuel input ratings exceeding 2930 kW (10 MMBtu/h),
- .6 Condenser water cooling towers:
 - .1 manufacturer and type,
 - .2 inlet and outlet air temperature, dry and wet bulb,
 - .3 inlet and outlet water temperature,
 - .4 motor, pump and fan information.
- .7 Motors:
 - .1 manufacturer,
 - .2 model or serial number,
 - .3 amperage and voltage,
 - .4 power rating,
 - .5 service factor,
 - .6 RPM,
 - .7 corrected full load amperage,
 - .8 measured amperage and voltage,
 - .9 calculated BHP (kW).
- .8 Fans:
 - .1 manufacturer,
 - .2 model or serial number,

- .3 flow rate,
- .4 static pressures (suction and discharge),
- .5 RPM,
- .6 pulley size, type and manufacturer,
- .7 belt size and quantity.
- .9 Pumps:
 - .1 manufacturer,
 - .2 model or serial number,
 - .3 flow rate,
 - .4 developed pump head,
 - .5 RPM.
- .10 Heat transfer equipment:
 - .1 manufacturer and type,
 - .2 inlet and outlet temperatures,
 - .3 pressure drop,
 - .4 design pressure rating (MAWP),
 - .5 flow rate,
 - .6 pressure relief valve rating (pressure setpoint, heat rating).

6 EXECUTION – MISCELLANEOUS

6.1 Balance Position Marking

- .1 Mark the balance position of dampers and valves at the completion of the final testing:
 - .1 ductwork: indicate with arrow using paint or permanent marker,
 - .2 exposed ductwork in public areas: self-adhesive label, placed adjacent to balancing damper, neatly filled in with % open or degree open value.
 - .3 valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.
- .2 Additional requirements for circuit-balancing valves with test ports:
 - .1 remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

7 EXECUTION - REPORT PRESENTATION AND VERIFICATION

7.1 Required Reports

- .1 Provide the following reports:
 - .1 Air and water balancing report,

7.2 Record Keeping

- .1 Keep records of trial and final balance and submit preliminary report as each system is completed.

- .2 Do not submit the final TAB report until all audit verification re-measurements, and any required re-balancing, is completed to the satisfaction of Consultant.

7.3 Report Format

- .1 Reports to incorporate approved standard forms, with values expressed in the same units as shown on Contract Documents.
- .2 Include "as-built" system schematics, marked-up to show as-measured flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for reference.
- .3 Submit an electronic PDF copy of the draft TAB report for review by Consultant. Where a report page length is more than 20 pages, include bookmarks in the PDF document organizes by system number and/or name.
- .4 After any revisions requested by Consultant have been made and final review accepted by Consultant, submit the final TAB report in the following formats:
 - .1 two (2) hard copies of the completed report, each with index tabs and bound in "D" ring binders,
 - .2 electronic file PDF copies by email or drop-box as coordinated with Owner and Consultant.

7.4 Completion

- .1 Continue TAB until reports are approved.
- .2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.
- .3 The substantial performance of the Work is not dependent upon alternate season testing.
- .4 The total performance of the Work will not be considered reached until the alternate season testing and balancing is completed and the final report submitted has been reviewed by Consultant and accepted by the Owner.

END OF SECTION

TESTING, ADJUSTING & BALANCING SUPPLEMENT FOR HEALTHCARE

23 05 93.23

1 GENERAL

1.1 Scope

- .1 Test, adjust, and balance ("TAB") airflows for rooms and spaces in healthcare facilities.
- .2 This section is supplementary to Specification section 23 05 93.13 and is to be read in conjunction with that section.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 05 93.13 Testing, Adjusting & Balancing for HVAC

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Differential airflow** – means the difference in the aggregate airflow rates of supply terminal outlets in a room or space minus the aggregate airflow rates of return air and exhaust air terminal inlets in the room or space, for design or measured flow rates.
 - .2 **Differential pressure** – means the design or measured air pressure of an enclosed room relative to the adjacent corridor, room, or space.
 - .3 **Negative pressure (room)** – means a room where the net airflow movement is from adjacent spaces into the room.
 - .4 **Neutral pressure (room)** – means a room where the net airflow movement into/out from the room is essentially zero but may have limited airflow into or out from the room.
 - .5 **Positive pressure (room)** – means a room where the net airflow movement is from the room to adjacent spaces,
 - .6 **Specialty Rooms** – means those room types as listed in Schedule A of this Specification section.

2 PRODUCTS

2.1 Not Used

3 EXECUTION

3.1 General

- .1 Balance air systems in accordance with Specification section 23 05 93.13 before performing room differential pressure balancing as specified herein.
- .2 For differential pressure, measure the room air pressure relative to the adjacent connecting corridor or room unless otherwise shown.
- .3 Where a space has dynamic differential pressure control, coordinate with the Division 25 contractor and supply measured data to allow configuration of Division 25 control sequences.

3.2 General Room and Space Differential Pressure Balancing Process

- .1 Application: all rooms and spaces that are not Specialty Rooms or Odour/Vapour Generating rooms specified herein.
- .2 For the purpose of this balancing process, the following definitions apply;
 - .1 A “positive pressure room” is one in which the design supply airflow rate exceeds the design return/exhaust airflow rates by 25 L/s (53 cfm) or more,
 - .2 A “negative pressure room” is one in which the design return/exhaust airflow rate exceeds the design supply air flow rate by 25 L/s (53 cfm) or more,
 - .3 A neutral pressure room is one that where the difference between the design supply airflow rate and the design return/exhaust airflow rate is less than 25 L/s (53 cfm).
- .3 Calculate the design differential airflow rates from design supply and return/exhaust airflow rates as shown on drawings. Record the design differential airflow rates in the TAB report.
- .4 Adjust room pressurization based on differential airflow:
 - .1 for positive and negative pressure rooms, adjust exhaust airflow rate until a balanced differential airflow of not less than 25 L/s (53 cfm), positive or negative as applicable to the room design differential airflow rate, is achieved unless a greater value is calculated or is as otherwise shown,
 - (a) acceptance criteria: measured differential airflow is within -0/+15% of design differential airflow.
 - .2 for neutral pressure rooms, adjust exhaust airflow rate until it is within the lessor of $\pm 5\%$ or 10 L/s (22 cfm) of the measured supply airflow rate,
- .5 Alternate method for rooms which are fully enclosed and provided with doors: balance room to achieve a differential pressure relative to adjacent connecting corridor or room, measured across the closed door;
 - .1 for positive pressure rooms, adjust exhaust airflow rate until a positive pressure of between +1.5 to +2.5 Pa (+0.006 to +0.01 in.w.c) is achieved and maintained for a time period of one (1) minute,
 - .2 for negative pressure rooms, adjust exhaust airflow rate until a negative pressure of between -1.5 to -2.5 Pa (-0.006 to -0.01 in.w.c) is achieved and maintained for a time period of one (1) minute,
 - .3 for neutral pressure rooms, adjust exhaust airflow rate until a relative pressure between -1.5 and +1.5 Pa (-0.006 and +0.006 in.w.c.) is achieved and maintained for a time period of one (1) minute.

3.3 Odour or Vapour Generating Rooms Differential Pressure Balancing Process

- .1 Application: washrooms, utility rooms, bathing rooms, shower rooms, wash-down rooms, waste storage rooms, and other contaminated storage rooms.
 - .1 Adjust room exhaust airflow rates to achieve a negative room differential pressure of not less than 2.5 Pa (0.03 in.w.c.) and maintained for a time period of two (2) minutes,
- .2 Acceptance criteria: measured differential pressure is within -0/+15% of design differential pressure.

3.4 Specialty Room Differential Pressure Balancing Process

- .1 Application: all rooms with permanent differential pressure sensors used for differential pressure control (directly or indirectly) as listed in Schedule A at the end of this specification section.
- .2 Adjust room airflow rates to achieve the required room differential pressure as listed in Schedule A at the end of this specification section, and which is maintained for a test time period of ten (10) minutes,
 - .1 for positive pressure rooms, adjust the return/exhaust airflow rates,

- .2 for negative pressure rooms, adjust the return/exhaust airflow rates. If necessary, the supply airflow rate may be reduced by up to 5% of design supply airflow value to achieve the required negative pressure.
- .3 For rooms which have anterooms (vestibules);
 - .1 first adjust airflow rates to achieve required differential pressure between the room and the connecting corridor,
 - .2 then adjust airflow rates in the anteroom to achieve required differential pressures.
- .4 Acceptance criteria: measured differential pressure is within -0/+15% of design differential pressure.

3.5 Site Acceptance Testing

- .1 After completion of differential pressure balancing, conduct Site Acceptance Testing ("SAT") of the Specialty Rooms in the presence and to the satisfaction of the Owner's representative(s) before equipment is permanently placed into service, for up to 10% of Specialty Rooms as selected by the Owner or Consultant.
- .2 SAT to include the following:
 - .1 Continuous measurement and recording of room differential pressure under static conditions, with all doors to the rooms closed for at least 5 minutes prior to the test, and measured for a period of ten (10) minutes,
 - .2 continuous measurement and recording of room differential pressure during an upset condition caused by the opening of a door to the connecting corridor for a period of 30 seconds;
 - (a) record the differential pressure vs time from the start of the door opening until time required after the door has closed for the room to return to 90% of the static differential pressure.

3.6 Commissioning Program

- .1 Comply with the project commissioning requirements in accordance with specification section 20 08 15 and Division 01 requirements.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separate from, the commissioning program, as coordinated with the Contractor and the commissioning authority.

3.7 Test and Installation Records

- .1 Provide the following test records to the Owner and a copy to Consultant.
 - .1 design and measured differential airflow and differential pressures for each room, to be included in the main TAB report,
 - .2 SAT results, to be included in the main TAB report.

3.8 Schedules

- .1 The following equipment schedules form part of this specification section.
 - .1 Schedule A: Specialty Room Differential Pressure Values

SCHEDULE A – Specialty Room Differential Pressure Values

Notes for the following table:

[1] Open areas with no physically closed interior boundary, or enclosed rooms where doors are frequently open.

[2] Unless otherwise stated, room pressure is measured relative to adjacent corridor serving the room.

Occupancy	Room Type	Measurement Parameter (minimum)	Positive or Negative [Note 2]
Healthcare	Treatment rooms, Operative birthing rooms, Operating rooms, Sterile storage and core spaces, Medical device reprocessing, Invasive imaging rooms,	2.5 Pa (0.01 in.w.c.)	Positive
	Biomedical waste treatment, Autopsy	2.5 Pa (0.01 in.w.c.)	Negative
	Protective Environment Rooms (PER)	7.5 Pa (0.03 in.w.c.)	Positive to corridor
	Airborne Isolation Rooms (AIR)	7.5 Pa (0.03 in.w.c.)	Negative to corridor
		7.5 Pa (0.03 in.w.c.)	Negative to adjacent (non-communicating) spaces
	AIR anteroom	2.5 Pa (0.01 in.w.c.)	Negative to corridor
			Positive to AIR room
	Combination PER/AIR Room	7.5 Pa (0.03 in.w.c.)	Positive to corridor (PER mode)
			Negative to Corridor (AIR mode)
	Combination PER/AIR Room Anteroom	2.5 Pa (0.01 in.w.c.)	Negative to corridor
			Negative to PER/AIR room
	Airborne Isolation Process Rooms	7.5 Pa (0.03 in.w.c.)	Negative to corridor
		2.5 Pa (0.01 in.w.c.)	Negative to corridor

Occupancy	Room Type	Measurement Parameter (minimum)	Positive or Negative [Note 2]
	Combination Airborne Isolation/Protective Isolation Process Room Anteroom		Negative to process room
Laboratories	Rooms with chemical fume hoods	2.5 Pa (0.01 in.w.c.)	Negative
	Rooms with biological hoods	5.0 Pa (0.02 in.w.c.)	Negative
Pharmacies	Hazardous compounding	2.5 Pa (0.01 in.w.c.)	Negative
	Hazardous compounding anteroom	5.0 Pa (0.02 in.w.c.)	Positive to corridor
		2.5 Pa (0.01 in.w.c.)	Positive to compounding room
	Clean compounding	12.5 Pa (0.05 in.w.c.)	Positive
	Clean compounding anteroom	7.5 Pa (0.03 in.w.c.)	Positive to corridor
		5.0 Pa (0.02 in.w.c.)	Negative to compounding room

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

HYDRONIC PIPING – CARBON STEEL

23 21 13.23

1 GENERAL

1.1 Scope

- .1 Provide carbon steel pipe and fittings for HVAC liquid piping systems. Refer to section 23 05 01 for piping system applicability.
- .2 This specification applies to liquid piping systems with design pressures not exceeding 2750 kPa (400 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified).

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 23 05 01 HVAC Piping Systems General Requirements
 - .3 23 25 05 HVAC Pipe Cleaning

1.3 Applicable Codes and Standards

- .1 Legislation:
 - .1 Refer to section 23 05 01.
- .2 Installation standards and codes:
 - .1 Refer to section 23 05 01.
- .3 Product standards:
 - .1 ANSI A21.11 Rubber Gasket joints for Ductile-Iron Pressure Pipe and Fittings
 - .2 ANSI B1.20.1 Pipe Threads, General Purpose (inch)
 - .3 ASME B16.1 Cast Iron Pipe Flanges And Flanged Fittings
 - .4 ASME B16.3 Malleable Iron Threaded Fittings.
 - .5 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .6 ASME B16.9 Factory Made Wrought Steel Buttwelding Fittings
 - .7 ASME B16.11 Forged Steel Fittings, Socket-Welding and Threaded
 - .8 ASME B16.20 Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
 - .9 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.
 - .10 ASME B16.39 Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.
 - .11 ASTM A47 Standard Specification for Ferritic Malleable Iron Castings.
 - .12 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - .13 ASTM A105 Standard Specification for Carbon Steel Forgings for Piping Applications

- | | |
|---------------|--|
| .14 ASTM A106 | Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| .15 ASTM A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| .16 ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both. |
| .17 ASTM A536 | Standard Specification for Ductile Iron Castings. |
| .18 CSA B242 | Groove and Shoulder Type Mechanical Pipe Couplings |

2 PRODUCTS

2.1 Pipe

- .1 Carbon steel:
 - .1 NPS 2 and under:
 - (a) ASTM A106 Gr B, schedule 40 seamless (S)
 - .2 NPS 2-1/2 to 10:
 - (a) ASTM A53 Gr B, schedule 40 Electric Resistance Weld (ERW).
 - .3 NPS 12 to NPS 18:
 - (a) ASTM A53 Gr B, schedule Standard (0.375 in. wall thickness) ERW.
 - .4 NPS 20 to NPS 24:
 - (a) ASTM A53 Gr B, schedule 30 ERW.

2.2 Pipe Joints and Fittings

- .1 Threaded fittings:
 - .1 End connections: NPT thread to ANSI B1.20.1.
 - .2 Fittings: Class 150 and Class 300, malleable iron to ASME B16.3..
 - .3 Unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39.
 - .4 Threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

Standard of Acceptance

- Masters Pro-Dope
 - Masters Orange or White Tape.
- .2 Welding fittings:
 - .1 Butt weld fittings:
 - (a) Forged to ASME B16.9,
 - (b) wall thickness to match pipe,
 - (c) long radius elbows.
 - .2 Welding outlet fittings:
 - (a) forged to ASTM A105,

- (b) dimensions and pressure ratings to MSS SP-97, Standard Class for butt welding branch connection and Class 3000 for threaded or socket welded branch connection,
 - (c) NPT ends to ASME B1.20.1.
- .3 Socket welded fittings:
 - (a) forged to ASTM A105,
 - (b) dimensions and pressure ratings to ASME B16.11, Class 3000.
- .4 Half couplings:
 - (a) forged carbon steel to ASTM A105,
 - (b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
 - (c) NPT ends to ASME B1.20.1.
- .3 Flanges:
 - .1 Flat-faced cast iron to ANSI B16.1, Class 125.
 - .2 Raised-face forged carbon steel to ASME B16.5, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.
 - .3 Studs and bolts: to ASTM A193, Grade B7,
 - .4 Nuts: to ASTM A194 Grade 2H or 2HM,
 - .5 Gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11.

Standard of Acceptance

- Chesterton - fig. 100, 195 and 450
- Beldam

- .4 Groove coupling joints:
 - .1 Couplings to CSA B242 with dry lubricated EPDM gaskets,
 - .2 Design ratings:
 - (a) Temperatures: -34°C (-30°F) to 110°C (230°F),
 - (b) pressure, maximum: 2400 kPa (350 psig),
 - .3 NPS 2 to 12:
 - (a) malleable iron to ASTM A47 or ductile iron to ASTM A536 for grooved piping in sizes NPS 2 ½ to 12,
 - (b) rigid version: provides a rigid pipe joint without axial or angular movement,
 - (c) flexible version: allow limited angular and axial offset,
 - (d) EPDM gaskets.

Standard of Acceptance

- Victaulic - fig. 107, 07 (rigid)
- Victaulic - fig. 177N (flexible)
- Gruvlok - fig. 7401 (rigid)
- Grovlok - fig. 7001 (flexible)
- Couplox
- Shurjoint

- .4 NPS 14 to 24:

- (a) segmented welded steel fittings in sizes NPS 14 and over,

- (b) coupling designed to comply as a rigid joint to ASME B31.1 and B31.9,
- (c) EPDM gaskets.

Standard of Acceptance

- Victaulic – AGS
- Gruvlok – series 7401-1

3 EXECUTION

3.1 Piping Installation

- .1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.
- .2 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:500 (0.2%);
 - .1 branch piping to have greater slope,
 - .2 slope piping up in direction of terminal heating and cooling devices,
 - .3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.
- .3 Use eccentric reducers at pipe size changes arranged flat-on-top to assist venting.
- .4 Cap ends during construction to prevent entry of foreign matter.

3.2 Class Rated Fittings and Flanges

- .1 Select ASME Class rated fittings and flanges in accordance with the following table for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Class	Maximum Design Pressure	Maximum Coincident Design Temperature
125 Note [1]	900 kPa (130 psi)	≤ 65°C (150°F)
125 Note [1]	700 kPa (100 psi)	≤ 121°C (250°F)
150	1720 (250 psi)	≤ 38°C (100°F)
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3700 kPa (535 psi)	≤ 38°C (100°F)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

Notes:

[1] For flanges only.

3.3 Pipe Joints and Fittings

- .1 Make pipe joints as follows.
 - .1 Piping NPS 2-1/2 and under:
 - (a) NPT threaded joint to ANSI B1.20.1 and made with Teflon tape or pipe dope, or

- (b) socket weld joints.
- .2 Piping NPS 2-1/2 and larger:
 - (a) welded,
 - (b) flanged.
 - (c) Grooved pipe and couplings.
- .3 For clarity, pipe size of NPS 2-1/2 may be either type of joint specified.
- .2 For flange joints, select gasket materials in accordance with the following table so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Chesterton Figure
80°C (180°F)	1720 kPa (250 psig)	Red rubber	1.6 mm (1/6 in)	100
200°C (390°F)	2400 kPa (350 psig)	Synthetic fiber with nitrile binder	1.6 mm (1/6 in)	450
400°C (750°F)	3700 kPa (535 psig)	Synthetic fiber with nitrile binder	1.6 mm (1/6 in)	195

3.4 Equipment connections

- .1 Make pipe connections to equipment as follows:
 - .1 NPS 2 and smaller: threaded fittings.
 - .2 NPS 2 ½ and larger:
 - (a) flanged connections,
 - (b) grooved end where equipment has compatible factory-prepared grooved ends
- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.

3.5 Welding

- .1 Comply with section 20 05 24 and as specified herein.

3.6 Branch Connections

- .1 Make branch connections to mains in accordance with Table 2a and 2b.
 - .1 These tables are valid for design pressures up to 2070 kPa (300 psig), without adding reinforcement material where branch pipe is directly welded to the main. For welded branch connections at higher design pressures, use butt weld, socket weld, or integrally reinforced outlet fittings only.
 - .2 In these tables, the following abbreviations apply.

Abbreviations:

TH	Threaded fitting to ASME B16.3
SW	Socket weld fittings to ASME B16.11

HC Half coupling to ASME B16.11
BW Buttweld fitting to ASME B16.9
OF Reinforced Outlet Fittings to MSS SP-97
DP Direct welding of Branch Pipe to Main without added reinforcement.

Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)										
Branch NPS	Mains Pipe, NPS									
	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10
3/4	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW HC DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/4	---	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/2	---	---	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
2	---	---	---	TH SW	BW SW	BW, OF SW	BW, OF SW DP	BW, OF DP	BW, OF HC DP	BW, OF HC DP
2-1/2	---	---	---	---	BW SW	BW, OF SW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
3	---	---	---	---	---	BW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
4	---	---	---	---	---	---	BW	BW, OF	BW, OF DP	BW, OF DP
6	---	---	---	---	---	---	---	BW	BW, OF	BW, OF DP
8	---	---	---	---	---	---	---	---	BW	BW, OF
10	---	---	---	---	---	---	---	---	---	BW

Table 2b – Allowable Branch to Main Connections (NPS 12 to NPS 30)								
Branch NPS	Mains Pipe, NPS							
	12	14	16	18	20	22	24	30
¾ to 2	OF HC DP	OF HC DP	OF HC	OF HC	OF HC	OF HC	OF HC	OF HC
2-1/2	OF DP	OF DP	OF	OF	OF	OF	OF	OF
3	OF DP	OF DP	OF	OF	OF	OF	OF	OF
4	BW OF DP	OF DP	OF	OF	OF	OF	OF	OF
6	BW OF DP	BW OF DP	BW OF	OF	OF	OF	OF	OF
8	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	OF	OF	OF
10	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
12	BW	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
14	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF	BW OF
16	---	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF
18	---	---	---	BW	BW OF	BW OF	BW OF	BW OF
20	---	---	---	---	BW	BW OF	BW OF	BW OF
22	---	---	---	---	---	BW	BW OF	BW OF
24	---	---	---	---	---	---	BW	BW OF
30	---	---	---	---	---	---	---	BW

- .2 Use of Class 3000 half-couplings as a branch connector ("HC"), and direct welding of branch piping to main piping ("DP"), is permitted in accordance with the following requirements:
- .1 half-coupling or branch pipe sits-on mains pipe, and does not insert into the main pipe,
 - .2 the opening size in the main pipe to closely follow the inside diameter of the half-coupling or branch pipe,
 - .3 half-coupling or branch pipe attachment end is shaped and beveled to closely following the surface of the main pipe, suitable for a pull-penetration weld,

- .4 the half-coupling or direct branch pipe is attached with a groove weld and covered with a smooth finishing fillet weld in accordance with the requirements of the applicable piping code.
- .3 Where integrally reinforced outlet fittings, half-couplings or direct welding of branch pipe is used, hole saw or drill and ream mains pipe to maintain full inside diameter of branch line prior to welding.
- .4 Where multiple branch pipes are to connect to the main pipe in close proximity to each other, provide a minimum separation between the centerlines of adjacent branch pipes equal to or greater than the sum of the OD dimensions of the adjacent branch pipes.
- .5 If threaded fittings have been installed where the specification requires welded fittings, either cut-out and replace the fitting, or fully seal-weld the exposed threads.
- .6 Where saddle type branch welding fittings are used on mains, hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding.

3.7 Groove Coupling Joint Installation

- .1 Use roll-groove joints; the use of cut-groove joints is only to be used on specific approval by Consultant.
- .2 Make pipe ends clean and free of indentations, projections and roll marks, between the end of the pipe and the groove.
- .3 Verify gasket style and material grade with supplier for use with intended service.
- .4 Provide for manufacturers' service representative to conduct on-site training prior to piping rough-in and installation.
- .5 Use rigid couplings in pipe risers and horizontal pipe runs.
- .6 The use of flexible couplings is limited to the following locations:
 - .1 for pipe drops to equipment in service rooms, to a maximum developed length of 5 m (16 ft) measured from the equipment pipe connection,
 - .2 where specified for seismic movement control purposes.
- .7 Where flexible couplings are used as described above, arrange and pay for the services of the grooved-joint manufacturer to:
 - .1 design the portion of the piping installation using the joints, include pipe supports,
 - .2 provide inspection services of the completed installation, and
 - .3 submit a written inspection report stating that the installation is in accordance with their design.

3.8 Pressure Testing

- .1 Conduct pressure and leak tests in accordance with section 23 05 01.

3.9 Flushing and Cleaning

- .1 After pressure testing, clean piping in accordance with Section 23 25 05.
- .2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:
 - .1 After cutting of threads and de-burring, and before installation of piping, manually clean the interior of the pipe with wire-brush on an extended rod, while washing the inside of the pipe with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear.
 - .2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.

- .3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.
- .4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

HYDRONIC PIPING - COPPER

23 21 13.33

1 GENERAL

1.1 Scope

- .1 Provide copper tube and fittings for HVAC liquid piping systems for aboveground and underground installations for the following applications:
 - .1 (as an alternative to steel piping) final connections not exceeding 1 m (39 in) in length to terminal heating units which have copper tube coils, copper tube heating elements, and copper tube radiant panels,
 - .2 tubing located in slabs or under slab-on-grade floors to connect to terminal heating or cooling units,
 - .3 drain and vent piping for equipment and piping systems (except cooling tower drainage piping).
 - .4 non-potable make-up water piping for HVAC services, or
 - .5 where otherwise shown.
- .2 This specification applies to liquid piping systems with design pressures not exceeding 2000 kPa (290 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified. Refer to section 23 05 01 for piping system applicability.
- .3 The use of copper tube is limited to nominal tube sizes NPS 3 and under.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 24 Welding and Brazing
 - .2 23 05 01 Heating and Cooling Piping Systems General Requirements
 - .3 23 25 05 HVAC Pipe Cleaning

1.3 Applicable codes and standards

- .1 Legislation:
 - .1 Refer to section 23 05 01.
- .2 Installation standards and codes:
 - .1 Refer to section 23 05 01.
- .3 Product standards:
 - .1 ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250
 - .2 ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - .3 ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges
 - .4 ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .5 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
 - .6 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings

- | | | |
|-----|-----------|--|
| .7 | ASTM A307 | Standard Specification for Carbon Steel Bolts and Studs 60,000PSI Tensile Strength |
| .8 | ASTM A563 | Standard Specification for Carbon and Alloy Steel Nuts |
| .9 | ASTM B32 | Specification for Solder Metal |
| .10 | ASTM B88 | Standard Specification for Seamless Copper Water Tube |
| .11 | ASTM B828 | Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings. |
| .12 | AWS A5.8 | Specification for Filler Metals for Brazing and Braze Welding |
| .13 | AWS A5.31 | Specification for Fluxes for Brazing and Braze Welding |
| .14 | AWS C3.4 | Specification for Torch Brazing |

2 PRODUCTS

2.1 Tube

- .1 Aboveground:
 - .1 NPS ½ to 2: to ASTM B88, type "L" hard-drawn copper tube.
 - .2 NPS 2-1/2 to NPS 3: to ASTM B88, type "K" hard-drawn copper tube.
- .2 Underground or in-slab:
 - .1 NPS ½ to NPS 3: to ASTM B88, type "K" hard-drawn or annealed copper tube.
- .3 Copper tube to be marked on the exterior surface in accordance with ASTM B88, to indicate the tube type ("K" or "L") by type designation or by colour strip (green stripe for type "K" and blue stripe for type "L"), along with identification of the manufacturer.

2.2 Tube Joints and Fittings

- .1 Fittings:
 - .1 cast bronze fittings to ASME B16.18,
 - .2 wrought copper and bronze fittings to ASME B16.22,
 - .3 brazed joints only: Wrought copper and copper alloy to ASME B16.50,
 - .4 threaded fittings including unions to ASME B16.15, Class 250.
- .2 Flanges:
 - .1 brass or bronze flanges to ANSI B16.24,
 - .2 gaskets to ANSI B16.21.

Standard of Acceptance

 - Chesterton - fig. 100, 195 and 450
 - Beldam
- .3 Solder:
 - .1 95:5 tin/antimony solder to ASTM B32.
- .4 Braze filler:
 - .1 silver brazing alloy: classification BCuP-5 to AWS A5.8.

3 EXECUTION

3.1 Tubing Installation

- .1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.
- .2 Maximum tube size: NPS 3.
- .3 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:1000 (c in in 10 ft).
 - .1 branch piping to have greater slope,
 - .2 slope piping up in direction of terminal heating and cooling devices.
 - .3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.
- .4 Use eccentric reducers at tube size changes arranged flat on bottom to assist venting.
- .5 Where tubing is installed to run inside of concrete slabs, support tubing to maintain tube centerline at the center of the floor slab unless otherwise shown. Where tubing is supported by ferrous metals or where it might come into contact with reinforcing steel bar, provide two layers of Denso Tape around the tubing at the point of contact.
- .6 Use copper tubing for equipment drains (pressure and non-pressure)
- .7 Provide di-electric unions or flanges in accordance with section 23 05 01.

3.2 Tube Joints and Fittings

- .1 Prepare and install tube and fittings;
 - .1 in accordance with ASTM B828 for solder joints,
 - .2 in accordance with AWS C3.4 and specification section 20 05
- .2 Use of direct butt weld style soldered or brazed joints, including pulled-Tee's, are not permitted.
- .3 Before assembling solder or brazed joints, remove working parts of valves.
- .4 Make tube joint for above-ground piping as follows:
 - .1 NPS 2 and smaller: soldered or brazed joints with socket type fittings.
 - .2 NPS 2-1/2 to NPS 3: brazed joints with socket type fittings.
- .5 Make tube joints for underground and/or in-slab piping as follows:
 - .1 all sizes: brazed joints with sweat fittings,
 - .2 arrange tubing to minimize the number of joints. Use annealed tubing wherever possible, with field-bends made with tube bending dies which provide uniform support of tubing during bending operations.

3.3 Equipment Connections

- .1 Equipment connections:
 - .1 NPS 2 and smaller: unions and threaded fittings,
 - .2 NPS 2 ½ to NPS 3: flanged connections.

3.4 Pressure and Leak Testing

- .1 Conduct pressure and leak tests in accordance with section 20 05 01.

3.5 Flushing and cleaning

- .1 After pressure testing, clean piping in accordance with Section 23 25 05.
- .2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:
 - .1 After cutting of threads and de-burring, and before installation of tubing, manually clean the interior of the tube with wire-brush on an extended rod, while washing the inside of the tube with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear,
 - .2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.
 - .3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.
 - .4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

END OF SECTION

HYDRONIC PIPING SPECIALTIES

23 21 16

1 GENERAL

1.1 Scope

- .1 Provide water piping specialty products for hydronic heating and cooling systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 05 01 HVAC Piping Systems General Requirements.
 - .2 20 05 49 Seismic Restraint
 - .3 25 30 19.16 Building Automation Pressure Independent Control Valves

1.3 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Product standards:
 - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
 - .2 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .3 CSA B51. Boiler and Pressure Vessel Code.

1.4 Seismic Qualification

- .1 Seismically qualify (certify) to remain operational after being subjected to the design seismic forces assuming a building height factor (NBCC) $A_x = 3.0$ with equipment rigidly mounted, by the shaker table method in accordance with Specification section 20 05 49.

1.5 Submittals

- .1 Submit manufacturer catalogue cut sheets for products specified herein.
- .2 Include confirmation of CRN.

1.6 Quality Control

- .1 All products are to have Canadian Registration Numbers in accordance with CSA B51.

2 PRODUCTS

2.1 Pressure Independent Balancing Valve (Automatic Balancing valve)

- .1 General
 - .1 Combination automatic flow limiting and commissioning pressure independent balancing valve.

Standard of Acceptance

- Bell & Gossett - Circuit Sentry Model WV Circuit Sentry

- .2 Design conditions:

- .1 Design pressure: NPS 2½ to 6: minimum 1700 kPa (250 psig)
- .2 Design temperature: -20°C to 111°C (-4°F to 230°F).
- .3 Flow control characteristics:
 - .1 pressure independent flow control over design flow range at an operating differential pressure range of 14 to 414 kPa (2 to 60 psi) across the valve body,
 - .2 minimum flow rate: 0.95 l/s (15 gpm)
 - .3 maximum allowable pressure drop: 10 kPa
 - .4 accuracy: ± 5% of control flow rate for total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
- .4 Valve body:
 - .1 body construction NPS 2 ½ to 6:
 - (a) ductile iron body, 304 stainless steel cartridge, EPDM O-ring packing design, reinforced EPDM diaphragm and a stainless-steel spring.
 - (b) wafer body style suitable for installation in ANSI Class 125, 150 or 250 flanges.
- .5 Accessories:
 - .1 two (2) 100 mm (4 in) long pressure/temperature ports,
 - .2 identification tag indicating unit size, and balanced flow rate.

2.2 Automatic Air Vents

- .1 Float operated with brass or cast iron body;
 - .1 minimum component pressure rating: 1000 kPa (150 psi) at 115°C (240°F),

Standard of Acceptance

- Armstrong - fig. AAE-750
- Bell & Gossett – fig. 87
- Maid-O-Mist - fig. 75
- Spirax Sarco - fig. AE30
- Taco - fig. Hy-Vent
- Thrush - fig. 720

2.3 Radiator Air Vents

- .1 Float operated with brass body;
 - .1 automatic type for remote installation for terminal heating units located at top of risers,
 - .2 screw-driver operated for locations inside of terminal heating unit enclosures other than when located at top of pipe risers,
 - .3 minimum component pressure rating: 1000 kPa (150 psi)

Standard of Acceptance

- Braukman - fig. EA122A
- Maid-O-Mist - fig. 37
- Spirax Sarco - fig. AE30
- Taco - fig. 417

2.4 Air Separator; Expansion Tank

- .1 Dip tube type air separator for installation at expansion tank,
 - .1 ASME code stamped to ASME BPVC Section VIII,
 - .2 Canadian Registration Number to CSA B51,
 - .3 cast iron body, with copper dip tubes, and stainless-steel ball check,
 - .4 minimum component pressure rating: 1030 kPa (150 psi) at 121°C (250°F).

Standard of Acceptance

- Bell & Gossett - fig. Airtrol Tank Fitting
- Armstrong

2.5 Air Separator; In-Line

- .1 Inertial centrifugal (vortex) style air and dirt separator, cast iron or fabricated steel body, with stainless steel mesh strainer,
 - .1 ASME code stamped to ASME BPVC Section VIII,
 - .2 Canadian Registration Number to CSA B51,
 - .3 pipe-ends: NPT threaded NPS 2 and under, ASME Class 150 flanged NPS 2-1/2 and larger,
 - .4 minimum component pressure rating: 1030 kPa (150 psi) at 121°C (250°F).

Standard of Acceptance

- Taco - fig. 4900
- Bell & Gossett – fig. Rolairtrol
- Amtrol - fig. Tangential Air Separator
- Armstrong - fig. Vortex VAS

2.6 Pressure Reducing Valves

- .1 Pressure reducing valve with integral inlet soft-seated check-valve and stainless steel mesh strainer;
 - .1 self-contained, single-seated, type,
 - .2 brass or cast iron body, EPT diaphragm, with fast-fill/purge release handle,
 - .3 pipe ends: NPT threaded,
 - .4 minimum component pressure rating: 860 kPa (125 psi) at 100°C (212°C),
 - .5 pressure regulator setting range:
 - (a) low range: 70 to 170 kPa (10 to 25 psi),
 - (b) high range: 170 to 410 kPa (25 to 60 psi).

Standard of Acceptance

- Bell & Gossett - fig. A430H
- Taco
- Watts

2.7 Pressure Relief Valves

- .1 Bronze or cast iron body pressure relief valve;
 - .1 stamped to ASME Section IV;

- .2 EPDM diaphragm and seat,
- .3 minimum component pressure rating: 860 kPa (125 psi) at 121°C (250°C),
- .4 selectable pressure setting range: 200 to 860 kPa (30 to 125 psi)
- .5 capacity rating: not less than associated heating boiler or unfired heat exchanger heat rating,
- .6 operating differential pressure from open to close not more than 20 kPa (3 psi).

Standard of Acceptance

- Bell & Gossett - fig. A-434E
- Watts - fig. 174A, 740

2.8 Wye-Pattern Strainers

- .1 NPS 3 and smaller:
 - .1 bronze, cast iron, or ductile iron bodies to ASME B16.1, with threaded cap,
 - .2 minimum component pressure rating:
 - (a) ASME Class 125: 1200 kPa (175 psi) at 93°C (200°F),
 - (b) ASME Class 250: 2270 kPa (330 psi) at 93°C (200°F),
 - .3 pipe end: NPT threaded or ASME flanged,
 - .4 basket: stainless steel, 0.8 mm ($1/32$ in) diameter perforations.
- .2 NPS 4 to NPS 24:
 - .1 cast steel or stainless steel bodies to ASME B16.5, with bolted flange cover,
 - (a) stainless steel body where installed in stainless steel piping system,
 - .2 minimum component pressure rating:
 - (a) ASME Class 150: 1800 kPa (260 psi) at 93°C (200°F),
 - (b) ASME Class 300: 3400 kPa (500 psi) at 93°C (200°F),
 - .3 pipe end: ASME Class raised face flanged,
 - .4 basket:
 - (a) stainless steel, 3.2 mm ($1/8$ in) diameter perforations,
 - (b) made from 0.9 mm (0.037 in) stock reinforced with 13 mm x 0.9 mm ($1/2$ in x 0.037 in) bands of same material spot welded to baskets,
 - .5 blow-down fitting in strainer cap: NPS 3/4 threaded connection with plug.

Standard of Acceptance

- Nibco
- Sure Flow
- Watts (Mueller)
- Zurn Wilkins

2.9 Basket- Pattern Strainers

- .1 NPS 2 to 20, simplex basket:
 - .1 in-line, single basket arrangement,
 - .2 cast steel or stainless steel bodies to ASME B16.5,

- (a) stainless steel body where installed in stainless steel piping system.
- .3 cover: same material as body, with quick-opening feature, to ASME Section VIII or ASME B16.5,
- .4 bottom blow-down fitting: NPS 3/4 threaded connection with plug,
- .5 minimum component pressure rating:
 - (a) ASME Class 150: 1800 kPa (260 psi) at 93°C (200°F),
 - (b) ASME Class 300: 3400 kPa (500 psi) at 93°C (200°F),
- .6 pipe ends:
 - (a) NPS 2 to 2-1/2: NPT threaded to ASME B1.20.1,
 - (b) NPS 3 to 20: ASME Class raised face flanged,
- .7 basket screens:
 - (a) perforated T304 stainless steel plate,
 - (b) NPS 2 and 3: 1.15 mm (3/64 in.) perforation, 36% open area,
 - (c) NPS 4 and over: 3.2 mm (1/8 in.) perforation, 40% open area.

Standard of Acceptance

- John Brookes (HART)
- Mueller (Watts)
- Spirax Sarco
- Sure Flow

2.10 Packaged Coil Valve Kits

- .1 Packaged installation valve-kits for terminal unit reheat coils, duct mounted reheat coils, and chilled water or dual temperature fan coils.

Standard of Acceptance

- Victaulic - fig. 79V Koil-Kit Coil Pac
- Belimo

- .2 Terminal device connection size range: NPS 1/2 to NPS 2.
- .3 Required MCPR for packaged assembly: 2100 kPa (300 psi) at 110°C (230°F).
- .4 Each packaged kit assembly to consist of:
 - .1 as individual components or as multi-function components,
 - .2 supply side:
 - (a) service isolation ball valve, Y-body strainer, valved and capped drain port, test plug port, union pipe-end fitting,
 - .3 return side;
 - (a) service isolation ball valve, pressure-independent electronic automatic control valve, manual air vent/test port, union pipe-end fitting,
 - (b) pressure-independent control valves to conform to Specification section 25 30 19.16.
 - .4 flexible hose connectors:
 - (a) at installation contractors option,
 - (b) for supply and return connections between coil and valve assemblies,
 - (c) maximum length: 300 mm (12 in.)

- (d) to Specification section 20 05 16 of all metal construction, or stainless steel braided guard with Teflon primary hose,
 - i) for clarity, where EPDM primary hose is used, the braided hose connector shall only be provided by the kit package manufacturer.
- .5 Packaging coordination services:
 - .1 shrink wrap each package coil kit, and identify package with an unique reference number and which identifies as a minimum;
 - (a) the applicable room number and floor level,
 - (b) associated equipment identification tag,
 - (c) contractor name, and project name.

3 EXECUTION

3.1 Equipment Selection Based on Pressure Rating

- .1 Unless otherwise specified herein or shown, select equipment that has a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.
- .2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select equipment as follows:
 - .1 select equipment with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.
 - .2 for clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

3.2 Pressure Independent Balancing Valve (Automatic Balancing Valve)

- .1 Manufacturer to select and provide valves to suit flow and differential pressure requirements. Include the information as a schedule in the shop drawing submittal.
- .2 Install balancing valve assembly with shut-off valve on either end of assembly.
- .3 Install balancing valve assembly in accordance with the manufacturer installation instructions. Provide companion flanges, mounting hardware and gaskets. Install in locations to provide five (5) pipe diameters of straight pipe before and two (2) pipe diameters after, which are free of fittings and valves.
- .4 Support balancing valve assembly rigidly from adjacent piping. Support piping within 300 mm (1 ft) of unit and flanges to prevent strain transmitted to assembly.
- .5 Manufacturer to supply a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

3.3 Air Vents Installation

- .1 Provide air vents at high points in the piping system, including at the top of all pipe risers, and in sections of piping subject to air binding, in both supply and return mains. Allow for additional air vents as directed by Consultant based on site review of installed work.
- .2 Provide isolating valves installed between unit and piping.
- .3 Pipe vent outlets to discharge to drain, over janitors sinks, over floor drains in mechanical rooms and other similar visible locations.

3.4 Radiator Air Vent Installation

- .1 Provide automatic radiator air vents on Ø20 mm (¾ in. dia.) by 50 mm (2 in) long air chambers on return side of hot water convactor-radiators and wall fin heaters connected to the top of flow risers. Pipe vent outlets to drain in visible locations.
- .2 Fit other hot water convactor-radiators with Ø20 mm (¾ in.dia.) by 150 mm (6 in) air chamber with manual screwdriver-operated air vent piped through front or side of cabinet. Fit similar air chamber and screwdriver operated air vent, through front or side of cabinet, on high points of other wall-fin heating elements except that air chamber to be as long as is possible to install within wall-fin enclosure height.
- .3 Install air vent assemblies clear of dampers within heating units.

3.5 In-Line Air Separator Installation

- .1 Provide in-line air separators in locations as shown. Provide an automatic air vent on top of the air separator, except where this connection is shown to be connected to a compression tank.
- .2 Provide a valved blow-down drain line from the air separator blow-down fitting, and extend piping to nearest floor drain. Arrange location of blow-down valve so that it is located within 500 to 1800 mm above the floor adjacent to the point of discharge to the floor drain.

3.6 Pressure Relief Valves Installation

- .1 Provide pressure relief valves on hot water boilers, heat exchangers, expansion tanks and other pressure vessels in accordance with relevant codes.
- .2 Select relief valve setpoints to be not greater than the maximum allowable working pressure of the protected equipment (for individual equipment).
- .3 For main pressure relief valves for piping systems, set the pressure relief valve setpoint to the value as shown.
- .4 Pipe relief valve outlets to drain.

3.7 Pressure Reducing Valves Installation

- .1 Install pressure reducing valves with shut-off valve on either side of assembly and Ø115 mm (4½ in. dia.) pressure gauges on upstream and downstream sides of the pressure reducing valve.

3.8 Strainers Installation

- .1 Provide pipeline-size strainers in each of following locations
 - .1 on the inlet side of water meters,
 - .2 on the inlet side of automatic control valves (except at reheat coils with piping connections NPS ¾ or less, radiation, or radiant panels),
 - .3 on the inlet side of pressure reducing valves (except where pressure reducing valve is equipped with an integral strainer),
 - .4 on suction side of water pumps (except where a pump suction guide with integral strainer is used),
 - .5 on inlets to heat exchangers (except where heat exchanger is equipped with integral strainers, or where a dedicated pump with strainer is directly supplying the heat exchanger).
- .2 Install wye-pattern strainers in horizontal or vertical-downflow orientation. Install basket strainers only in horizontal piping.
- .3 Install strainers with clearance for removal of basket.

- .4 For strainers NPS 2½ and over, provide NPS 1 valved blowout connection, consisting of ball valve with hose end and chained cap. Pipe valved blowout connections from strainers at pumps to open drain.

3.9 Packaged Coil Valve Kits Installation

- .1 The use of packaged coil valve-kits are at the contractor's option in lieu of providing site assembly of separate valves and fittings.
- .2 Coordinate with the trade contractor under Division 25 for the supply of pressure independent control valves for inclusion in the coil valve kits.
- .3 Create and provide a schedule of valve kits required to the manufacturer/packager, which includes the following information:
 - .1 a designation indicating the location of the applicable HVAC equipment,
 - .2 design flow rates of the applicable HVAC equipment,
 - .3 manufacturer/packager to select and size the pressure-independent control valves in accordance with Specification section 25 30 19.16.
- .4 Arrange piping to HVAC equipment so that flexible connector hoses are not bent to change direction. Flexible connector hoses may be deflected laterally by an amount not exceeding the outside diameter of the connector hose. Where necessary, provide a rigid elbow at the HVAC coil-end connections.

END OF SECTION

AIR DISTRIBUTION - GENERAL

23 31 01

1 GENERAL

1.1 Scope

- .1 Provide labour, materials and equipment for installation, testing and putting into operation ventilating and air conditioning systems

1.2 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

2 PRODUCTS

2.1 Not Used

3 EXECUTION

3.1 Ductwork

- .1 Ductwork system routing is shown diagrammatically. Drawings are not considered to be fabrication or installation drawings.
- .2 Locate mains, risers and runouts to be concealed behind furrings or above ceilings except in mechanical equipment rooms and access spaces where ductwork is to be exposed.
- .3 Determine areas without ceilings from Architectural Drawings and Room Finish Schedules, and in these areas keep ductwork as high as possible.
- .4 Anchor, guide and support vertical and horizontal runs of ductwork to resist dead load and absorb thrust.

3.2 Air Supply Equipment

- .1 Install and connect air handling units, and air conditioning units, and build casing and plenums.

3.3 Air Exhaust Equipment

- .1 Install and connect exhaust fans, roof and wall exhausters and dust and fume collectors.

3.4 Terminals Devices

- .1 Locate and install terminal boxes, registers, diffusers, and grilles

3.5 Life Safety

- .1 Install fire dampers, smoke dampers, and combination smoke and fire dampers to protect openings in fire separations.
- .2 Provide smoke stopping around unprotected ducts passing through smoke separations.

3.6 Air Balancing

- .1 Co-operate with air balancing agency; install supplementary dampers, access openings and access doors to facilitate testing and adjustment.

END OF SECTION

METAL DUCTS 23 31 13.13

1 GENERAL

1.1 Scope

- .1 Provide metal HVAC ductwork including casings and plenums as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 49 Seismic Restraint
 - .2 23 33 05 Duct Accessories.

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section and as applicable to related sections.
 - .1 **Casing(s)** – a fabricated metal construct of some combination of walls, roofs, and/or floors for the conveyance of air at relatively low air velocities (typically below 5 m/s (1000 fpm) and which encloses equipment such, as but not limited to, fans, coils, and filters.
 - .2 **Ductwork** – a network of metallic or flexible material distributed through a building or space for the conveyance of air: (a) from an HVAC unit to one or more spaces, or (b) exhausted from those spaces.
 - .3 **Plenums** – a form of ductwork for the conveyance of air at relatively low velocities (typically below 3.5 m/s (700 fpm)).
- .2 In SMACNA 006 - *HVAC Duct Construction Standard – Metal and Flexible*, a reference to requirements for construction of “casings” in chapter 9 applies equally to construction of plenums, except/and as specified herein.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 ASHRAE Letter and number designations, shown as “CR3-16” etc., are taken from ASHRAE Duct Fitting Data Base.(DFDB)
 - .3 ANSI/SMACNA 006 HVAC Duct Construction Standards - Metal and Flexible (4th edition)
 - .4 ANS/SMACNA 002 Rectangular Industrial Duct Construction Standards (2nd edition)
 - .5 ANSI/SMACNA 016 HVAC Air Duct Leakage Test Manual (2nd edition)
- .2 Product standards:
 - .1 ASTM A90 Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
 - .2 ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
 - .3 ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

- | | | |
|-----|----------------|--|
| .4 | ASTM A1011 | Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| .5 | ASTM A283 | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| .6 | ASTM A36 | Standard Specification for Carbon Structural Steel |
| .7 | ASTM A480 | Specification for General requirements for Flat Rolled Plate, Sheet, and Strip |
| .8 | ASTM A463 | Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| .9 | ASTM B209 | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| .10 | ANSI/MSS SP-58 | Pipe Hangers and Supports |

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.6 Design Criteria

- .1 Outdoor ductwork, rooftop duct support frames, and weather shields are to be designed to meet the local wind loading in accordance with the building code requirements at the location of the Work.
- .2 Seismic design loading for duct supports to conform to Specification section 20 05 49.

1.7 Submittals

- .1 Submit manufacturer's catalogue literature for:
 - .1 proprietary joints.
- .2 Submit fabrication shop drawings for the following ductwork elements:
 - .1 integral drain pans and external drain pans including drain pipe connection,
 - .2 water-resistant ductwork,
 - .3 casings and plenums.
- .3 Submit schedules and details to show;
 - .1 fabrication details of:
 - (a) connections to risers in duct shafts,
 - (b) construction of casings and plenums,
 - (c) balancing damper construction,
 - (d) fittings where geometry contemplated is different from that specified.
 - .2 in chart form for each system, for the following data:
 - (a) duct system pressure class,
 - (b) duct sheet gauges and required reinforcement by duct size,
 - (c) joint types and application criteria,
 - (d) location criteria and dimensions for bracing, stiffeners, and balancing dampers,
 - (e) duct leakage class, and

(f) extent of sealing.

1.8 As-Built Drawings

- .1 As work progresses, mark-up field drawings as to actual location of ductwork, balancing dampers and other duct accessories and submit as part of record of "As-Built" conditions.

2 PRODUCTS

2.1 Common Material

- .1 Galvanized steel:
 - .1 Ducts and connectors: lock forming quality to ASTM A653 or ASTM A924, type Z180 (G60) or Z275(G90) as specified in Part 3 – EXECUTION.
 - .2 Miscellaneous pipe, angles, strips and threaded rod in contact with ductwork: galvanized with a minimum thickness equal to ASTM A653 - Z180 (G60).
- .2 Stainless steel:
 - .1 to ASTM A480, Type 304L,
 - .2 finish: 2B mill, except where otherwise shown.
- .3 Aluminum:
 - .1 To ASTM B209;
 - (a) alloy 3003-H14 or 5052-H32 for sheet material.
 - (b) alloy 6061-T6 for plate material
 - (c) alloy 6061-T4 or T6 for shapes material.
- .4 Plain mild carbon steel:
 - .1 To ASTM A1011, A283, A572 and A36 as applicable.

2.2 Joints

- .1 Fabricated joints: to ANSI/SMACNA 006 as applicable to duct pressure class, duct size, duct-wall thickness, and reinforcing requirements.
- .2 Bolted companion flange – rectangular ductwork:
 - .1 formed flanges, corner pieces, integral edge seals, gaskets and cleats.
 - .2 material to match that of ductwork being joined,
 - .3 Neoprene gaskets.

Standard of Acceptance

- Ductmate – fig. System 25/35/45
- Hardcase (Carlisle) – fig. Nexus

- .3 Barrel-rim clamped companion flange – round ductwork:
 - .1 roll-formed companion flanges, field installed, mechanically fastened and sealed to ends of duct,
 - .2 barrel ring clamp with bolted or no-tool cam locking clamp,
 - .3 Neoprene gaskets.

Standard of Acceptance

- Ductmate - fig. Spiralmate
- Nordfab - fig. Quick-Fit Ducting

2.3 Sealant and Tape

- .1 To Specification section 23 33 05.

2.4 Hangers and Supports

- .1 Upper hanger attachments;

- .1 in new concrete: manufactured concrete inserts.

Standard of Acceptance

- Myatt Fig. 485

- .2 for steel joist: galvanized joist clamps or steel plate washer.

Standard of Acceptance

- Anvil Fig. 61 or 86
- Anvil Fig. 60 for plate washer

- .3 for steel beams: galvanized beam clamps.

Standard of Acceptance

- Anvil Fig. 60

- .2 Hanger straps:

- .1 Galvanized steel strap hangers for indoor use only.

- .3 Hanger rod:

- .1 Continuous threaded rod:

- (a) carbon steel, USS national course thread,
- (b) tension load ratings to MSS SP-58,

Standard of Acceptance

- Anvil - fig. 146
- Taylor – fig. 54

- .2 Welded eye rod:

- (a) carbon steel, USS national course thread,
- (b) tension load ratings to MSS SP-58,
- (c) tension load rating to be the same as continuous welded rod.

Standard of Acceptance

- Anvil - fig. 278
- Taylor

- .4 Seismic supports and restraints to Specification section 20 05 49.

2.5 Rooftop Duct Support System

- .1 Prefabricated rooftop duct, HVAC equipment, and conduit supports, supported without penetrations of the roof membrane or flashings:
 - .1 to ANSI/MSS SP-58, Type 62, 63 and 64,
 - .2 high density polypropylene roof bases, with UV protection,
 - .3 roof pads suitable for roof type,
 - .4 minimum 2.5 mm (12 ga.) thick formed channel structure
 - .5 minimum 1.9 mm (14 ga.) thick supplementary support
 - .6 galvanized steel duct support mounting channels,
 - .7 modular mounting channels and clips for conduit,
 - .8 designed to withstand local wind loading and seismic movement,
 - .9 for ductwork 300 x 300 mm (12 in x 12 in) and larger,
 - .10 for conduit Ø12 mm to Ø100 mm.

Standard of Acceptance

- Portable Pipe Hangers
- Miro (Unistrut)
- Taylor Pipe Supports

2.6 Duct Access Doors

- .1 To Specification section 23 33 05.

3 EXECUTION

3.1 General Fabrication and Installation Requirements

- .1 Construction details, sheet gauges, reinforcing, and bracing for ductwork, casings, and plenums to be in accordance with SMACNA 006, except/and as otherwise shown.
- .2 Material selection: refer to Schedule A at the end of this section where otherwise shown.
- .3 Rectangular ductwork seams and joints:
 - .1 longitudinal seams: Pittsburgh Lock, with specified sealant applied prior to hammering of joint,
 - .2 transverse joints: to SMACNA HVAC standards based on pressure class and reinforcement used, and for sealing requirements.
- .4 Round ductwork seams and joints, 500 Pa (2 in wg) pressure class and higher:
 - .1 spiral flat type longitudinal seam, button punched.

3.2 Sheet-Metal Plenums

- .1 Provide sheet metal plenums with dimensions as shown. Construct plenums as follows:
 - .1 single wall construction,
 - .2 constructed of the same material as adjacent duct except as otherwise shown,
 - .3 50 mm (2 in.) flanges or as required to suit ductwork or damper connections.
- .2 Design loading:

- .1 where a horizontal plenum has an internal vertical dimension greater than 1000 mm (39 in.) and with a concurrent width greater than 600 mm (24 in.) and has access doors to allows entry of an adult person into the plenum, design the plenum and support system to support a live point load of 1.3 kN (300 lbf) over a contact area of 300 x 300 mm² (12 x 12 in²).
- .3 Additional requirements for outdoor intake air plenums and exhaust air plenums:
 - .1 construct the bottom of the plenum as an integral drain pan as specified herein.
 - .2 drain pan material: same as plenum material.

3.3 Integral Drain Pans

- .1 Where shown or specified, construct the bottom portion of a duct, casing or plenum as a watertight drain pan.
- .2 Materials: same material as the associated duct, casing or plenum unless otherwise shown.
- .3 Break the bottom panel in two-directions to allow water to drain to a low-point drain outlet,
- .4 Provide continuous welded joints along bottom of plenum, and extend welds up vertical joints at least 50 mm (2 in.).
 - .1 For galvanized steel materials, touch-up ductwork where galvanization is damaged during welding with zinc-rich paint.
 - .2 For stainless steel materials, mechanically grind or chemical pickle to remove the welding tint in the heat affected zone (HAZ).
- .5 Provide a NPS 3/4 x 75 mm (3 in.) long stainless steel drain tube connected to the duct drain pan at the low-point drain outlet.

3.4 External Drain Pans

- .1 Provide external drain pans where shown.
- .2 Materials: T304 stainless steel.
- .3 Fabricate drain pan with 50 mm (2 in.) high side walls.
- .4 Break the bottom panel in two-directions to allow water to drain to a low-point drain outlet,
- .5 Provide welded-on hanger attachments to allow support by hanger rod or support the underside of the drain pan.
- .6 Provide continuous welded joints along bottom of plenum, and extend welds up vertical joints. Mechanically grind or chemical pickle both the interior and exterior surfaces at the welds to remove the welding tint in the heat affected zone (HAZ).
- .7 Provide a NPS 3/4 x 75 mm (3 in.) long stainless steel drain tube connected to the duct drain pan at the low-point drain outlet.

3.5 Balancing Dampers

- .1 Provide splitter dampers where branch connections are taken from supply mains.
- .2 Provide single blade dampers on each branch of supply air systems downstream of terminal boxes.
- .3 Provide Opposed Blade Dampers (OBD) at branch and main connection on exhaust and return air systems.

3.6 Finishing, Fastening and Supports

- .1 Hammer edges and slips to leave smooth finished surface inside duct.

- .2 Support vertical ducts with steel angles riveted to duct and bearing on building structure.
- .3 Duct hangers;
 - .1 For ducts with both dimensions not exceeding 500 mm (20 in):
 - (a) supported with strap hangers of same material as duct but one sheet metal thickness heavier, or on steel angles as specified below.
 - (b) extend strap hangers down duct side and turn under 50 mm (2 in) fastening securely to side and underside of duct.
 - .2 For ducts with any dimension greater than 500 mm (20 in):
 - (a) supported with trapeze hangers constructed from galvanized steel angle with steel rods in accordance with table 1;

Table 1 : Duct Hangers		
Duct size mm (in)	Angle size mm (in)	Rod size mm (in)
up to 750 (up to 30)	25x25x3 (1x1x $\frac{1}{8}$)	6 ($\frac{1}{4}$)
750 to 1050 (30 to 40)	40x40x3 (1 $\frac{1}{2}$ x1 $\frac{1}{2}$ x $\frac{1}{8}$)	6 ($\frac{1}{4}$)
1050 to 1500 (40 to 60)	40x40x3 (1 $\frac{1}{2}$ x1 $\frac{1}{2}$ x $\frac{1}{8}$)	10 ($\frac{3}{8}$)
1500 to 2400 (60 to 90)	50x50x3 (2x2x $\frac{1}{8}$)	10 ($\frac{3}{8}$)
2400 and over (90 and over)	50x50x6 (2x2x $\frac{1}{4}$)	10 ($\frac{3}{8}$)

- .3 Maximum hanger spacing: 2.4 m (8 ft) on centre.
- .4 For additional requirements for seismic restraints, refer to Section 20 05 49.

3.7 Outdoor Ductwork Installation

- .1 Construct outdoor ductwork in accordance with the requirements for indoor ductwork, and/except as follows.
- .2 Construct galvanized steel duct using Z275 (G90) sheet metal.
- .3 Support ductwork on a manufactured rooftop duct support framing system, specifically designed and fabricated to suit each outdoor duct.
- .4 Where seismic restraint is required;
 - .1 provide both a bottom support beam and top support brace.
 - .2 provide restraint at both sides at the top of the duct, at the specified restraint spans, with minimum Ø12 mm stainless steel bolt, nuts and washers, fastened to the duct support system post and to a duct mounting bracket. Fasten the mounting brackets to the stop corners of the duct with 2@ #10 sheet-metal screws.
- .5 For uninsulated ductwork;
 - .1 support ducts on a steel angle fastened to the underside of the duct, and bolt the steel angle to the duct support frame bottom crossbar,
 - .2 where fastened to the bottom crossbar, provide slotted bolt holes and oversize washer plates to allow 6 mm (1/4 in) duct axial movement for thermal expansion, and to resist wind and seismic movement.

.6 For insulated ductwork;

- .1 support ducts on a steel angle fastened to the underside of the duct, which extend not more than 50 mm (2 in) past each side of the duct. Do not penetrate the duct insulation with the steel angles.
- .2 support the duct on threaded rods from the support frame bottom crossbar, to provide sufficient space between the underside of the duct and the crossbar to accommodate the required insulation thickness and protective finish cover, plus an additional 25 mm (1 in),
- .3 insert a section of 25 mm (1 in) thick high-density polystyrene insulation equal to Owners Corning Celfort 300, between the duct insulation and top of the support crossbar,
- .4 snug down the mounting bolts to provide adequate compression onto the polystyrene insert.

3.8 Water-resistant Ducts for Wet Process Exhaust, Humidifiers and Showers

.1 General construction requirements for water penetration-resistant ductwork:

- .1 weld longitudinal and transverse joints,
- .2 where ducts have integral drain pans, run a NPS 3.4 copper or stainless steel tube drain from drain pan to nearest floor drain. Provide a 100 mm (4 in.) deep water trap at drain pan connection.

.2 Wet process exhaust:

- .1 application: owners equipment which has a direct or indirect exhaust duct for conveying high-humidity exhaust air, including:
 - (a) direct exhaust connections to dishwashers, tunnel washers, cage washers, and similar equipment, and
 - (b) indirect exhaust grilles or canopies over process equipment doors such as sterilizers, sanitizers, autoclaves, and similar equipment.
- .2 material: in accordance with Schedule A at the end of this section,
- .3 ductwork limits: extended from on duct connections on equipment (direct exhausting) or grille or exhaust canopy (indirect exhaust) to inlet connection at exhaust fan.
- .4 for directly connected exhaust ducts, construct the horizontal duct from connection to the process equipment with an integral drain pan as specified herein;
 - (a) horizontal duct sloped back to drain into process equipment connection where horizontal run is less than 3m (10 ft),
 - (b) horizontal duct sloped in the direction of airflow to the base of the duct riser where horizontal run is more than 3 m (10 ft), and provide a NPS ¾ drain connection from low points in bottom of duct.

.3 Duct-mounted humidifiers:

- .1 application: duct-mounted humidifiers, not located in an air handling unit.
- .2 material: in accordance with Schedule A at the end of this section,
- .3 ductwork limits: extended a minimum of 1.0 m (3 ft) upstream and 3.0 m (10 ft) downstream from humidifier,
- .4 duct section constructed with an integral drain pan as specified herein, with drain pan sloping down in direction of airflow, so that the bottom of the integral drain pan at the leaving end of the duct section is at least 50 mm (2 in.) lower than adjacent downstream duct.

.4 Shower exhaust ducts:

- .1 application:

- .2 material: in accordance with Schedule A at the end of this section,
- .3 ductwork limits: commencing at connection to exhaust grilles and extending a minimum of 1500 mm (5 ft) from shower exhaust grilles and sloped to drain back through exhaust grilles served.

3.9 Pressure Classification and Seal Class

- .1 Low pressure ductwork construction classification in accordance with Table 2.

Table 2: Duct Pressure Classification			
Pressure class Pa (in wg)	Operating pressure Pa (in wg)	Velocity m/s (fpm)	Leakage Test Pressure Pa (in wg)
125 (½)	up to 125 (½)	10.0 (2000)	125 (½)
250 (1)	125 to 250 (½ to 1)	12.5 (2500)	250 (1)
500 (2)	250 to 500 (1 to 2)	12.5 (2500)	500 (2)
750 (3)	500 to 750 (2 to 3)	15.0 (3000)	750 (3)
Greater than 750 (3)	High Pressure Ductwork		Not less than 1000 (4)

- .2 Assemble ductwork seams and joints with joint sealant as shown in table 3.
- .3 Sealant application:
 - .1 store duct sealant at room temperature for 24 hours before use,
 - .2 apply sealant on seams as noted in table 1, and brush or extrude sealant to cover fasteners,
 - .3 on bell and spigot style joints apply sealant on male section with caulking gun and spread sealant evenly on mating surface with brush,
 - (a) insert fitting and secure with sheet metal screws
 - (b) brush sealant onto outside of assembled joint in 50 mm (2 in) wide band covering fastener heads,
 - .4 allow 40 hours curing time before pressure testing.

Table 3: Duct System Pressure and Seal Class				
No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
1	Induction unit supply from fan discharge to unit plenum box inlet.	+1000 (4) and up	A	Transverse joints, longitudinal seams, ductwall penetrations, and other connections
2	Supply risers in vertical service space (duct shafts).	+1000 (4)	B	Transverse joints, longitudinal seams, and other connections
3	Supply air ductwork from discharge side of fan to inlet of terminal box or reheat coil in healthcare and laboratory facilities.	+1000 (4)		

Table 3: Duct System Pressure and Seal Class

No.	Ductwork System	Static pressure construction class Pa (in.wg.)	Seal class	Sealing requirements (1)(2)(3)(4)
4	Return/exhaust air ductwork between HEPA filters and suction side of fan.	-1000 (4)		
5	Return/exhaust air ductwork between a Heat Recovery Wheel and suction side of fan.	-1000 (4)		
6	Autopsy exhaust ductwork.	-1000 (4)		
7	Supply air ductwork from discharge side of fan to inlet of terminal box or reheat coil; Return air ductwork on discharge side of fan.	+750 (3)		
8	Return/Exhaust risers in mechanical rooms and vertical service spaces (duct shafts).	-750 (3)		
9	Supply air ductwork upstream of HEPA filters, including diffusers with integral HEPA filters. ⁽⁵⁾	+750 (3)		
10	Return and/or exhaust air ductwork on suction side of fans <u>other than</u> in mechanical rooms and vertical service spaces.	-500 (2)	C	Transverse joints and other connections
11	Supply air ductwork on downstream side of terminal units or reheat coil; Exhaust air ductwork on discharge side of fan; Fan coil units, suction and discharge.	250 (1)	C	Transverse joints only
12	Supply air and return air ductwork from roof top air conditioning units, 5 tons or less	125 (½)	D	No sealing

Notes for table 3:

- (1) *Transverse joints* are connections of two duct or fitting elements oriented perpendicular to flow,
(2) *Longitudinal seams* are joints oriented in direction of flow,
(3) *Duct wall penetrations* are openings made by screws, non-self-sealing fasteners, pipe, tubing, rod and wire,
(4) *Other connections* such as spin-ins taps and other branch fittings inserted into cut openings in duct, access door frames, insertion type control elements and duct joints at equipment are to be treated as *transverse joints*.
(5) *This pressure class also applies to supply ductwork downstream of a terminal box or reheat coil which serve diffusers with integral HEPA filters.*

3.10 Fittings - Rectangular Ductwork

- .1 Refer to Schedule B at the end of this section for illustrations of referenced fitting types.
- .2 Elbows:
- .1 Elbows are to be installed as shown, or if not shown, in descending order as listed in table 4.
- (a) for clarity, elbows types are to be selected based on the highest order number (where 1 is the highest) which will fit the available space.

Table 4: Rectangular Duct, Elbows						
Order No.	ASHRAE Fitting No.	Description	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Minimum Throat Radius mm (in)	Remarks
1	CR3-1	Smooth radius Un-vaned elbow	1.5	≤ 300 (12)	---	Default
			1.0	> 300 (12)	---	
2	CR3-3	Smooth radius Vaned elbow	0.75	≤ 900 (36)	150 (6)	One full radius single thickness splitter vane
	CR3-4	Smooth radius Vaned elbow	0.75	> 900 (36) ≤ 1500 (60)	150 (6)	Two full radius single thickness splitter vane
	CR3-5	Smooth radius Vaned elbow	0.75	> 1500 (60)	150 (6)	Three full radius single thickness splitter vane
3	CR3-15	Square Mitred Vaned elbow	Square throat; Square heel.	--	---	Double thickness turning vanes; 50 (2) heel radius vane; 54 mm (2.125 in) vane spacing.
4	CR3-2	Radius Heel Sharp Throat	0.5	---	---	Double thickness turning vanes as per CR3-3, 4 or 5 depending on duct width

.2 First elbow on discharge side of fan:

(a) fitting CR3-1, un-vaned elbow with throat radius 1.0 times duct width, with the required upstream effective length L_e of straight length of duct in accordance with fitting type SR7-5 or SR7-9 as applicable.

.3 Wye and tee branch fittings - Supply air systems:

.1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 5.

Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
1	For 750 Pa (3 in.wg) pressure class and above: branch take-off from ducts in shafts, and ducts upstream of terminal boxes, filters and reheat coils	Smooth radius wye; diverging	SR5-1
		Dovetail wye	SR5-14
		Divided flow fittings	(SMACNA) 4A or 4B
		45° entry branch diverging	SR5-13
2	Supply ducts downstream of terminal boxes, fan coil units, reheat coils or heat pumps	Tee, rectangular main to round conical tap	SR5-12

Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
		Tee, 45° entry branch diverging	SR5-13
		Smooth radius wye; diverging	SR5-1

.4 Wye and tee branches - Return/Exhaust air systems:

- .1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 6.

Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Return/Exhaust Air Systems			
Ref. No.	Return/Exhaust Ductwork System	Fitting Type	ASHRAE Fitting No
1	All pressure classes including branch connections at duct shafts	Smooth radius wye; converging	ER5-1
		Dovetail wye	ER5-4
		Divided flow fittings	(SMACNA) 4A or 4B
		45° entry branch diverging, where shown on drawings	ER5-3

.5 Transitions (Rectangular and Round):

- .1 converging: maximum 20° angle between duct side and direction of flow,
.2 diverging: maximum 15° angle between duct side and direction of flow.

.6 Fabricate duct offsets using elbows selected in accordance with table 2 and as follows:

- .1 single offset in single plane, less than duct height: made up with two 45° elbows,
.2 single offset, of greater displacement, made up with 90° elbows,
.3 double offset in single plane, less than duct height, made up with four 45° elbows,
.4 double offset in single plane, of greater displacement than duct height, made up with 90° elbows.

.7 Obstructions passing through duct:

- .1 covered by round nosed streamline enclosure where free area of duct is reduced by less than 15%,
.2 fitted in round nosed streamline enclosure with duct width increase, SMACNA HVAC FIG 2-10, Detail E , with converging and diverging transition angle requirements as specified above.

3.11 Fittings - Round Ductwork

- .1 Refer to Annex A at the end of this Section for illustrations of referenced fitting types.
.2 Elbows:
.1 Elbows are to be installed as shown, or if not shown, in order of available space as listed in table 6.

Table 6 : Round Duct, Elbows					
Ref. No.	Description	ASHRAE Fitting No.	Throat Radius Ratio R/W	Duct Width Limit mm (in)	Remarks
1	30° elbow	CD3-3*	1.5	≤ 300 (12)	Die stamped
		CD3-14*	1.5	> 300 (12)	2-Gore
2	45° elbow	CD3-3	1.5	≤ 300 (12)	Die stamped
		CD3-14	1.5	> 300 (12)	3-Gore
3	60° elbow	CD3-3*	1.5	≤ 300 (12)	Die stamped
		CD3-14*	1.5	> 300 (12)	4-Gore
4	90° elbow	CD3-1	1.5	≤ 200 (8)	Die stamped
		CD3-9	1.5	>200 (8) and ≤ 350 (14)	5-Gore
		CD3-10	1.5	>350 (14) and ≤ 900 (36)	7-Gore
			2.5	> 900 (36)	7-Gore

.3 Wye branches:

- .1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 7.

Table 7 : Round Duct, Wye and Tee Branch Fittings			
Ref. No.	Supply Ductwork System	Fitting Type	ASHRAE Fitting No
1	Downstream of supply fan.	Wye branch plus 45° elbow	SD5-2
		Tee, tapering	SD5-12
2	Downstream of terminal boxes.	Wye branch plus 45° elbow	SD5-1
		Tee, tapering	SD5-10
3	Return or exhaust duct branches.	Wye branch plus 45° elbow	ED5-2
4	Return or exhaust duct branches; equal main and branch duct size.	Tee, tapering, with 45° elbow	SD5-2
5	Return or exhaust duct branches; smaller branch size.	Tee, tapering, with 45° elbow	SD5-12

3.12 Temporary Protection of Duct Openings

- .1 Cap off ends of unfinished ducts while plastering, drywall and other finishing operations are in progress,

- .2 Cover open ends or registers of active exhaust/return ducts with 25 mm (1 in) thick filter media secured with tape. Maintain media until dust producing finishing operations are completed.

3.13 Duct Access Coors

- .1 Provide for inspection and servicing of duct mounted components and cleaning of duct system;
- .1 located such that any section of duct is not more than 15 m (50 ft) from point of access
 - .2 at not more than 6 m (20 ft) intervals on supply air ductwork installed after HEPA filter,
 - .3 at base of each accessible duct riser,
 - .4 in front of and behind duct mounted coils,
 - .5 at activation side of fire, smoke, and combination fire/smoke dampers,
 - .6 and motorized dampers where damper actuator is located inside of duct or plenum.
- .2 Door size:
- .1 Select access door sizes based on smallest duct dimension in accordance with table 8.

Table 8 : Access Door Sizes			
Smallest Duct Dimension mm (in)	Bottom of duct height above floor m (ft)	Location	Door Size mm (in)
≤ 350 (14)	Any	Side or bottom	300 x 150 (12x6)
>350 and ≤500 (>14 and ≤20)	Any	Side or bottom	450 x 250 (18x10)
>500 (>20)	≤3.6 (12)	Side or bottom	530x350 (21x14)
	>3.6 (12)	Bottom	635x430 (25x17)

3.14 Duct Pressure Testing

- .1 Duct pressure testing must be completed to the satisfaction of Consultant before ductwork is insulated or concealed.
- .2 Pressure test air duct systems for leaks at 1.33 times the system, or portion of the system, pressure class specified and as follows;
- .1 between supply air handling units and terminal units,
 - .2 between supply air handling units and final connection to supply outlets on supply systems without terminal units (excluding flexible ductwork)
 - .3 between inlet grilles and the exhaust/return fan inlet,
 - .4 between the return fan discharge outlet and the mixing plenum on recirculating return systems,
 - .5 between the exhaust fan discharge outlet and the point of discharge before leaving the building, but only for process exhaust systems conveying any materials other than general building exhaust air,
- .3 The following parts of system are exempt from pressure testing;

- .1 short duct runs of 15 metres (45 feet) or less, operating at 37 Pa (1/8 in) SP or less.
- .2 ductwork installed downstream of terminal boxes and fan coil units.
- .4 Conduct test in accordance with Associated Air Balance Council (AABC) recommended procedures.
- .5 Where audible air noise is detected during test, remove test, pressure apply sealant to leaking joints and seams, and retest after 48 hours. Continue testing and sealing until leaks are inaudible.

3.15 Duct Leakage Testing

- .1 Duct leakage testing must be completed to the satisfaction of Consultant before ductwork is insulated or concealed.
- .2 Conduct duct leakage tests in accordance with SMACNA *HVAC and Duct Leakage Test Manual* and as specified herein.
- .3 For each duct systems, calculate the maximum allowable ductwork airflow leakage rate based on duct surface area, pressure class and duct seal class in accordance with the following:

$$L = F \times D_{SA}$$

$$\text{and } F = K \times C_L \times P^{0.65}$$

where these parameters are unique to each section of duct:

- L is the maximum allowable leakage airflow rate,
- D_{SA} is the duct surface area,
- F is the leakage rate coefficient,
- C_L is the duct leakage class, and is listed in Table 11,
- P is the duct design pressure,
- K is a conversion factor depending on the units of measure and is listed in Table 9.

Table 9: Duct Leakage Measurement Units			
	Parameter	Flow Measurement Units	
		L/s	CFM
L	Allowable leakage units	L/s	CFM
D_{SA}	Duct surface area units	m ²	ft ²
F	leakage rate coefficient	L/s per m ²	CFM per 100 ft ²
C_L	Leakage Class	Refer to table 11 below	Refer to table 10 below
P	Duct Class pressure units	Pa	in.w.c.
K	unit conversion (multiplier)	1.4×10^{-3}	1

Table 10: Leakage Coefficient, C_L			
Duct Type	Seal Class		
	C	B	A
Rectangular metal	24	12	6

Table 10: Leakage Coefficient, C_L			
Duct Type	Seal Class		
	C	B	A
Round Metal	12	6	3
Unsealed rectangular metal duct	48	48	48
Unsealed round or oval metal duct	30	30	30

- .4 Conduct duct leakage tests for each duct system at an air pressure equal to the duct system pressure class. Where a duct system has multiple pressure classes for different sections, test each section of the system independently.
- .5 If leakage rate exceeds the calculated maximum allowable value, examine ductwork for excessive leakage, re-seal and then repeat the leak test until the measured leakage rate is less than the calculated maximum allowable value for the section of the system under test.
 - .1 for clarity, where a duct system consists of multiple sections of different pressure classes, the acceptance criteria is based on not exceeding the aggregate of the calculated maximum allowable leakage of all sections in the same duct system.
- .6 Maintain a set of drawings on site, coloured each day during testing to indicate extent of duct satisfying leakage criteria under test.
- .7 Submit a written report, verified by the TAB Agent, identifying each segment of duct system tested, showing calculation of maximum allowable leakage (duct surface area, pressure class, seal class, leakage class " C_L " and calculated leakage air flow rate for the section), along with the test pressure and measured leakage airflow rate, and certifying that leakage testing has been satisfactorily completed.
- .8 Submit the report for review by Consultant before duct insulation is installed and branch take-offs are made for terminal units.

3.16 Duct Cleaning

- .1 Cleaning to be performed by agent specializing in this field of work, be a member in good standing with National Air Duct Cleaners Association (NADCA), and to comply with NADCA standards.
- .2 Clean new horizontal and vertical ducts (supply, return, exhaust, transfer), as well as existing supply and return ductwork connected to new fan systems.
- .3 Clean ductwork using high powered vacuum system, hand tools and mechanical brushing systems such that metal surfaces are visibly clean.
- .4 Reset balancing dampers to original settings if moved during work. Have TAB Agent confirm damper settings.
- .5 Maintain set of drawings on site, coloured each day during cleaning to indicate extent of duct cleaning completed.
- .6 Submit a written report, verified by TAB Agent, identifying extent of duct system cleaning and certifying that NADCA standards have been met.

3.17 Schedules

- .1 The following schedules form part of this specification section.
 - .1 Schedule A – Ductwork, Casings and Plenum Materials

.2 Schedule B – Illustrations of Referenced Fittings.

Schedule A – Materials for Ductwork, Casings and PlenumsLegend

"Yes" means permitted material

"---" means not permitted

Where more than one material is indicate as permitted for a particular application or location,
than any of those permitted materials may be used.

Application or Location	Galvanized Steel Z180 (G60)	Galvanized Steel Z275 (G90)	Stainless Steel	Aluminum	Notes
Outdoors	---	Yes	Yes	---	[1]
Intake air plenums	---	Yes	Yes	---	[1]
Exhaust air plenums	---	Yes	Yes	---	[1]
Parking garages	---	Yes	Yes	---	[1]
Indoor swimming pools and spas	---	---	Yes	Yes	[2]
Shower rooms	---	---	Yes	Yes	
Indoor painted ductwork	---	Yes	---	---	
Owner Process Equipment Exhaust	---	---	Yes	---	[2]
Duct-mounted humidifiers	---	---	Yes	---	
Shower exhaust ducts	---	---	Yes	Yes	
Buried ductwork	---	PVC Coated	Yes	---	
All other indoor locations	Yes	Yes	---	---	

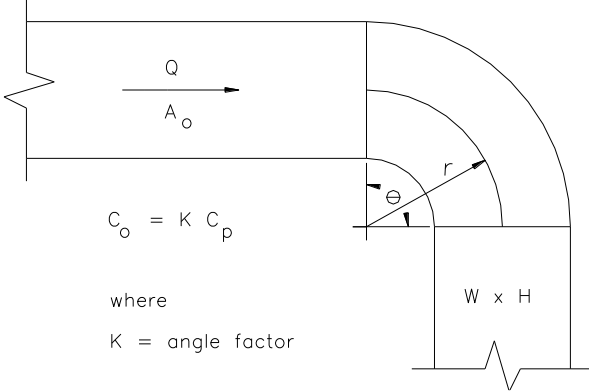
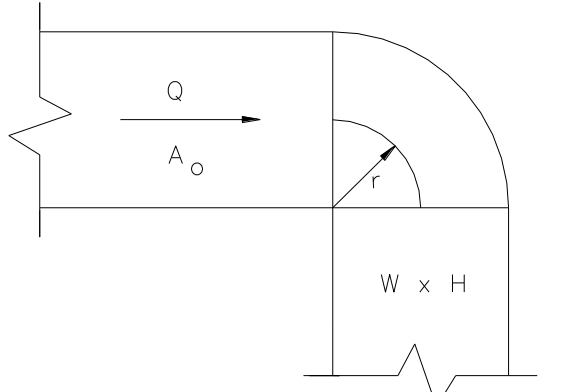
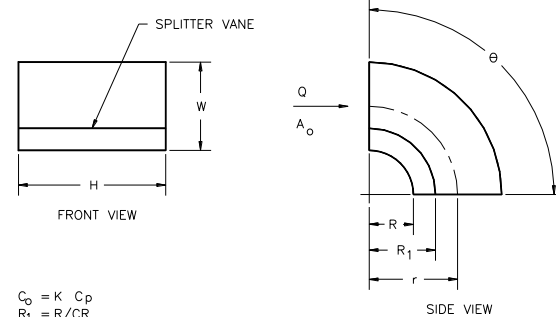
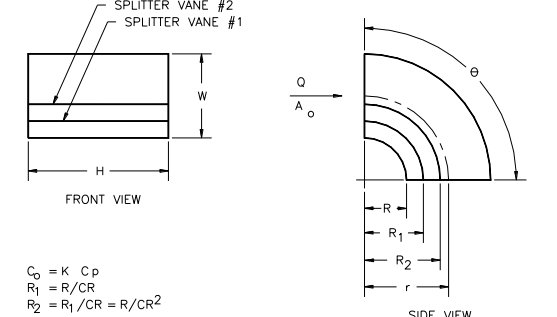
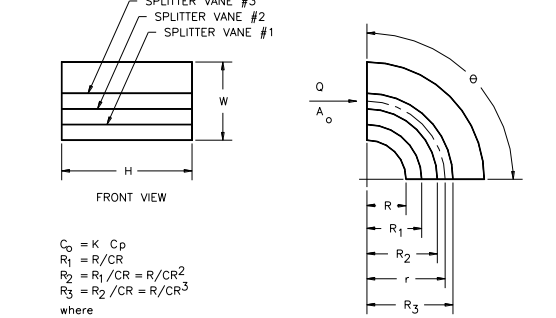
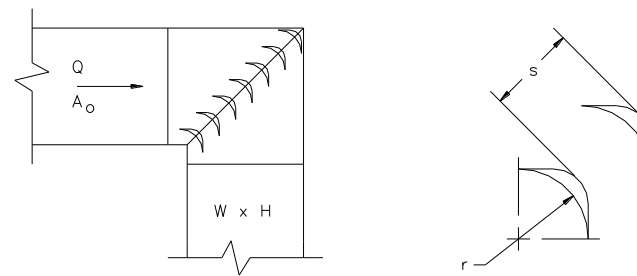
Notes:

[1] For both insulated and uninsulated ductwork.

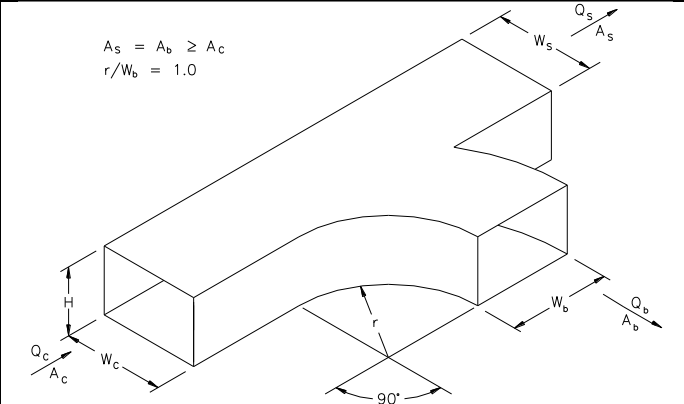
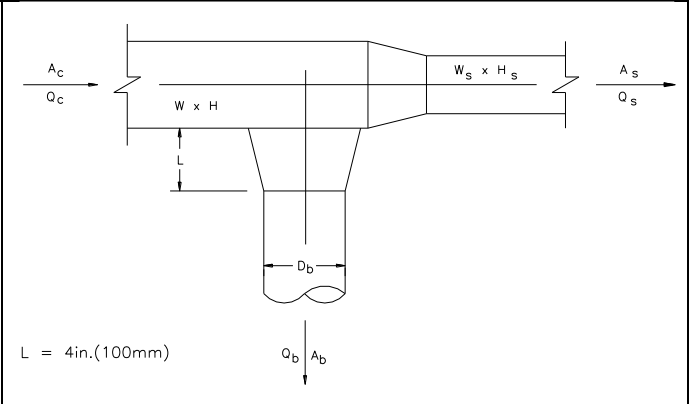
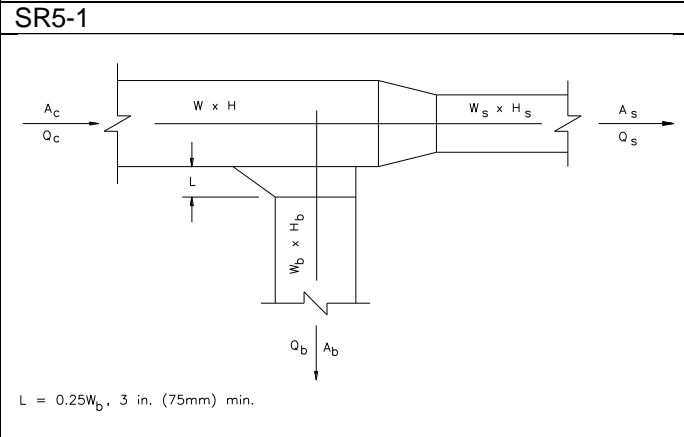
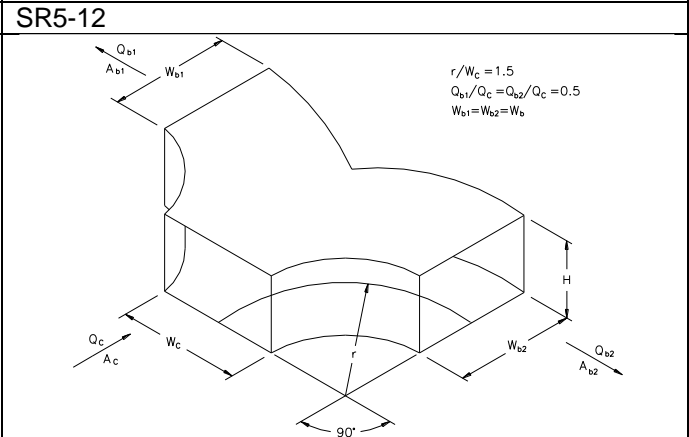
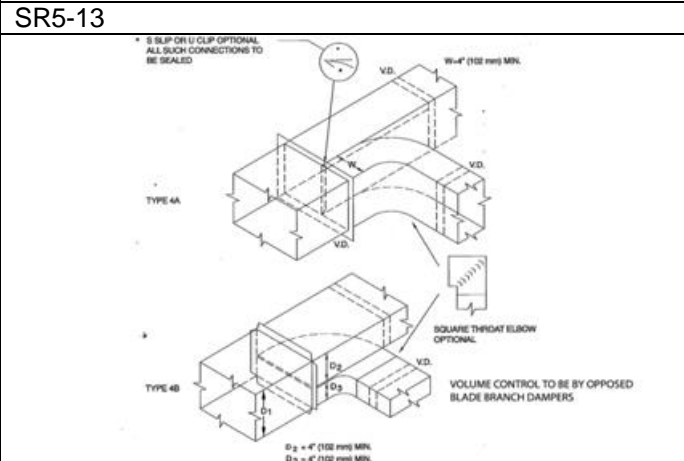
[2] No. 4 brushed finish for exposed ductwork and hoods, No. 2B mill finish for concealed ductwork.

Schedule B – Illustration of Referenced Fittings

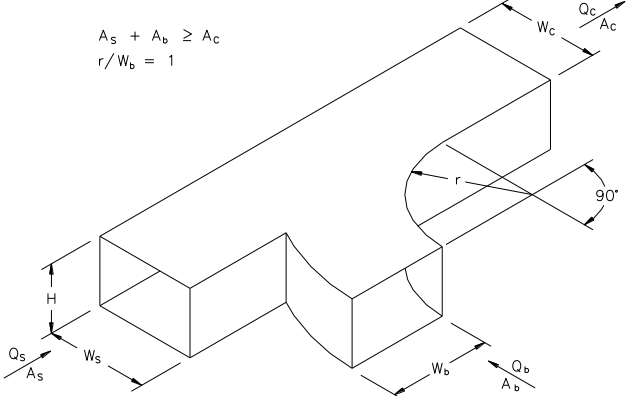
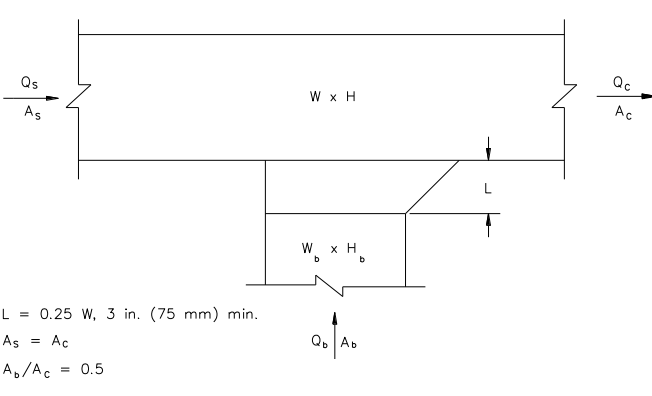
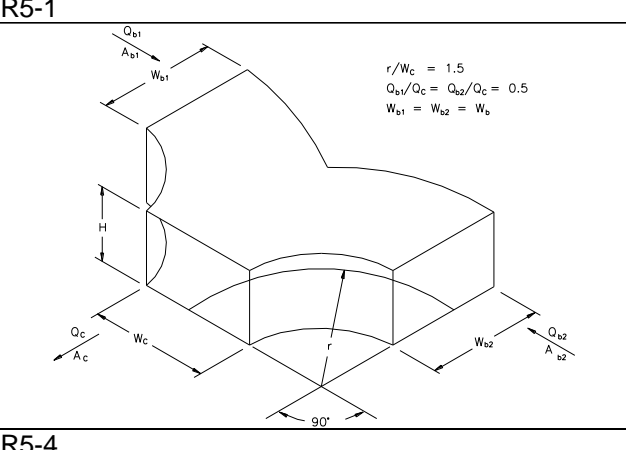
Rectangular Elbows (see Table 4 in Part 3.)

 <p> $C_o = K C_p$ where $K = \text{angle factor}$ </p>	
<p>CR3-1</p>  <p> $C_o = K C_p$ $R_1 = R/CR$ where $R = \text{throat radius}$ $R_1 = \text{splitter vane radius}$ $CR = \text{'CURVE RATIO'}$ $K = \text{angle factor}$ </p> <p style="text-align: right;">CR3-3</p>	<p>CR3-2</p>  <p> $C_o = K C_p$ $R_1 = R/CR$ $R_2 = R_1/CR = R/CR^2$ where $R = \text{throat radius}$ $R_1 = \text{splitter vane \#1 radius}$ $R_2 = \text{splitter vane \#2 radius}$ $CR = \text{'CURVE RATIO'}$ $K = \text{angle factor}$ </p> <p style="text-align: right;">CR3-4</p>
<p>CR3-3</p>  <p> $C_o = K C_p$ $R_1 = R/CR$ $R_2 = R_1/CR = R/CR^2$ $R_3 = R_2/CR = R/CR^3$ where $R = \text{throat radius}$ $R_1 = \text{splitter vane \#1 radius}$ $R_2 = \text{splitter vane \#2 radius}$ $R_3 = \text{splitter vane \#3 radius}$ $CR = \text{'CURVE RATIO'}$ $K = \text{angle factor}$ </p> <p style="text-align: right;">CR3-5</p>	<p>CR3-4</p>  <p> $r = 2.0 (50), s = 2.125 (60) \text{ in. (mm)}$ </p>
<p>CR3-5</p>	<p>CR3-15</p>

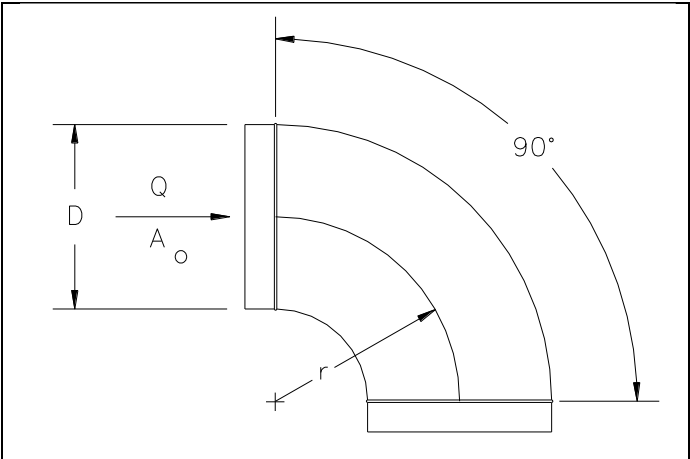
Rectangular Wyes and Tee's – Supply Ductwork (see Table 5 in Part 3)

 <p>$A_s = A_b \geq A_c$ $r/W_b = 1.0$</p>	 <p>$L = 4 \text{ in. (100 mm)}$</p>
SR5-1	SR5-12
 <p>$L = 0.25W_b, 3 \text{ in. (75 mm) min.}$</p>	 <p>$r/W_c = 1.5$ $Q_{b1}/Q_c = Q_{b2}/Q_c = 0.5$ $W_{b1} = W_{b2} = W_b$</p>
SR5-13	SR5-14
 <p>* S SLIP ON U CLIP OPTIONAL. ALL SUCH CONNECTIONS TO BE SEALED.</p> <p>TYPE 4A</p> <p>TYPE 4B</p> <p>SQUARE THROAT ELBOW OPTIONAL</p> <p>VOLUME CONTROL TO BE BY OPPOSED BLADE BRANCH DAMPERS</p> <p>$W = 4" (102 \text{ mm}) \text{ MIN.}$ $D_1 = 4" (102 \text{ mm}) \text{ MIN.}$ $D_2 = 4" (102 \text{ mm}) \text{ MIN.}$ $D_3 = 4" (102 \text{ mm}) \text{ MIN.}$</p>	
SMACNA Fig. 4A/4B	

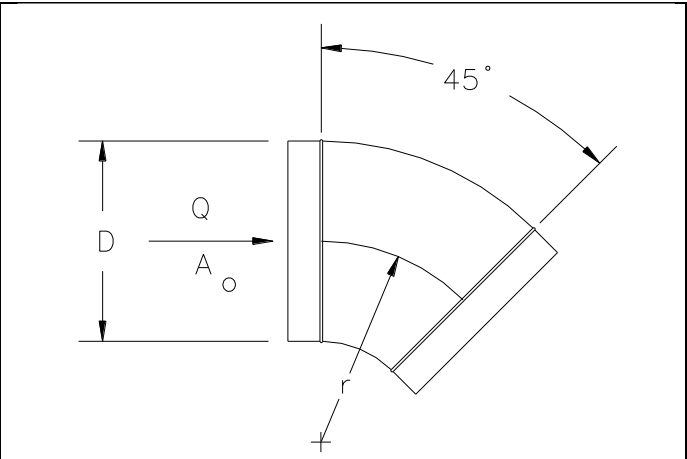
Rectangular Wytes and Tee's – Return/Exhaust Ductwork (see Table 5 in Part 3)

 <p>$A_s + A_b \geq A_c$ $r/W_b = 1$</p>	 <p>$A_s = A_c$ $A_b/A_c = 0.5$</p>
 <p>$r/W_c = 1.5$ $Q_{b1}/Q_c = Q_{b2}/Q_c = 0.5$ $W_{b1} = W_{b2} = W_s$</p>	<p>ER5-3</p>

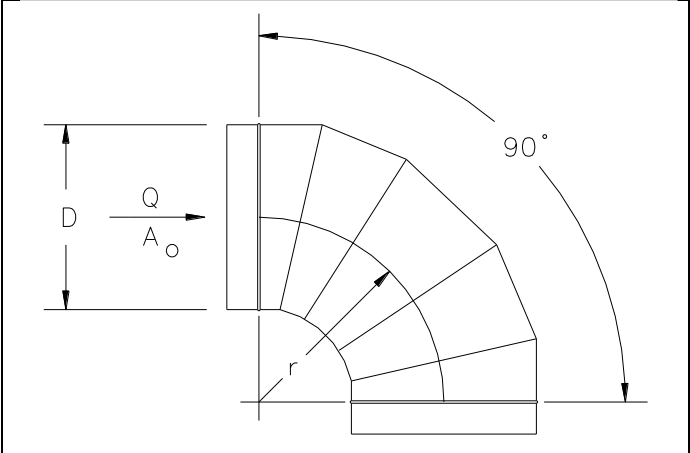
Round Elbows (see Table 6 in Part 3)



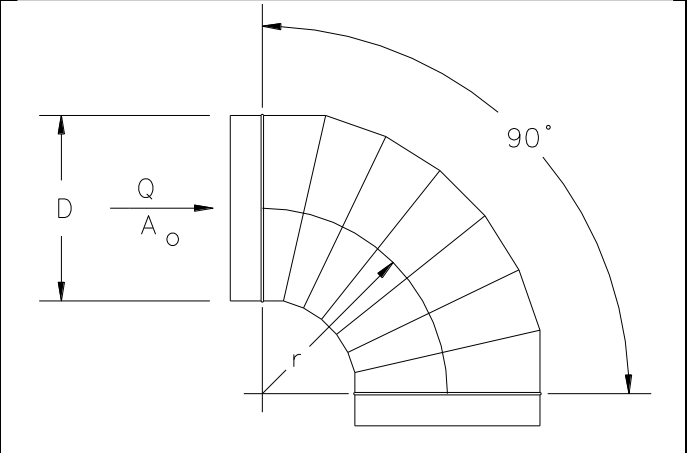
CD3-1



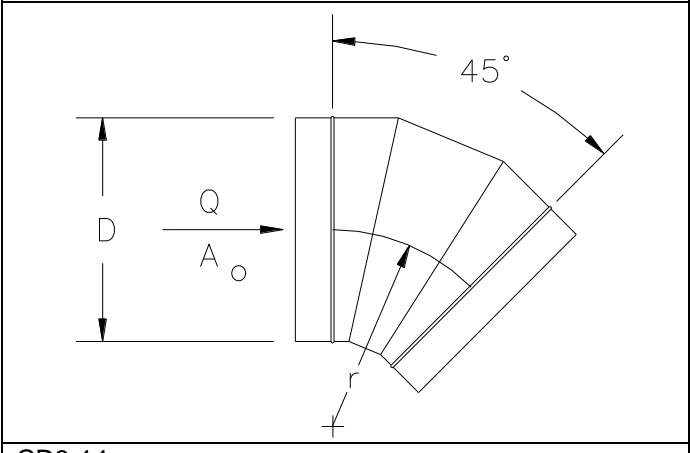
CD3-3



CD3-9

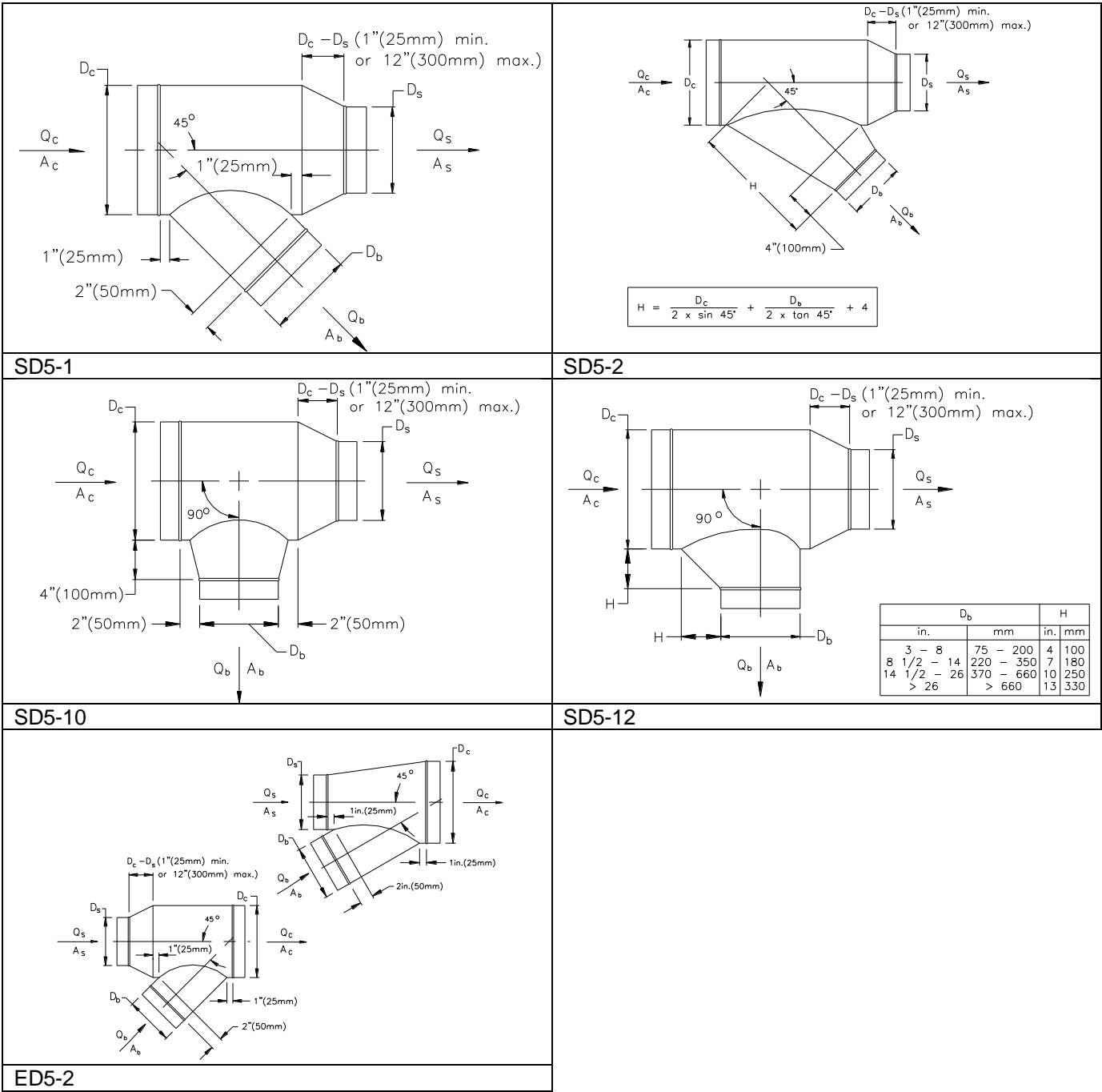


CD3-10



CD3-14

Round Wyes and Tees (see Table 7 in Part 3)



END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

DUCT ACCESSORIES

23 33 05

1 GENERAL

1.1 Scope

- .1 Provide duct accessories as shown.

1.2 Submittals

- .1 Submit product data sheets for:
 - .1 flexible connections
 - .2 sealants
 - .3 tapes
 - .4 duct access doors and hardware
 - .5 instrument test ports

2 PRODUCTS

2.1 Flexible Connections

- .1 Neoprene:
 - .1 galvanized 0.66 mm (24 ga) sheet metal frame, with fabric clenched with double locked seams,
 - .2 fire resistant, self-extinguishing, neoprene coated glass fabric,
 - .3 operating temperature: -40°C to 90°C (-40°F to 194°F),
 - .4 density: 0.653 kg/m² (0.13 lb/sq ft) in conventional systems.

Standard of Acceptance

- Duro-Dyne - Durolon
- Ventfabric - Ventglas
- Elgin - Neoprene

- .2 Vinyl coated, insulated:

- .1 flame resistant, 0.56 mm (0.022 in) thick vinyl coated fabric envelope, enclosing 32mm (1¼ in), 12kg/m³ (0.75 lb/cu ft) fiberglass insulation,
- .2 operating temperature: 82°C (180°F) continuous and 93°C (200°F) intermittent,
- .3 installed;
 - (a) in connections for insulated duct systems,
 - (b) in circular duct connections subject to negative pressure with diameter less than 250mm (10 in), and
 - (c) in rectangular duct connections subject to negative pressure with smallest side less than 300mm (12 in)

Standard of Acceptance

- Duro-Dyne - Insulflex

.3 Non-grease duct exhaust - silicon rubber:

- .1 silicon rubber coated woven fiberglass fabric to UL 214,
- .2 operating temperature: up to 260°C (500°F),
- .3 density of 0.461 kg/m² (0.094 lb/sq ft),
- .4 installed for kitchen, kitchen and fume hood, and fume hood exhaust systems.

Standard of Acceptance

- Duro-Dyne - Thermafab

2.2 Sealant

- .1 water based polymer emulsion type flame resistant duct sealing compound.
- .2 operating temperature range: -29°C to 93°C (-20°F to 200°F).

Standard of Acceptance

- Bakor 530 - 14
- RCD #6
- 3M Fastbond 900
- Childers CP-145a & CP-146
- United Duct Sealer (water based)
- Duro Dyne DWN (water based)

2.3 Tape

- .1 polyvinyl treated open weave glass fibre tape, 50mm (2") wide.

Standard of Acceptance

- Duro-Dyne FT-2

2.4 Duct Access doors

- .1 Construction - uninsulated duct or plenum:
 - .1 shop or field fabricated from same material as duct, one sheet metal thickness heavier but not less than 0.6mm (26ga.) thick,
 - .2 with gasketed sheet metal angle frame.
- .2 Construction - insulated duct or plenum:
 - .1 shop fabricated as double wall insulated sandwich, of same material as duct, one sheet metal thickness heavier but not less than 0.6mm (26ga) thick,
 - .2 with gasketed sheet metal angle frame and 25 mm (1 in) thick rigid glass fibre insulation.
- .3 gasketed with neoprene or foam rubber.
- .4 fitted with hardware as follows: two sash locks for doors up to 300 mm x 300 mm (12 in x 12 in).
 - .1 four sash locks for doors up to 301 mm x 450 mm (13 in x 18 in).
 - .2 piano hinge and minimum 2 sash locks for doors up to 451 mm x 1000 mm (19 in x 40 in)
 - .3 piano hinge and 2 handles operable from both sides for doors over 1000 mm (40 in) in height.

Standard of Acceptance

- Duro-Dyne SP-21 for door handles

2.5 Instrument Test Ports

.1 Construction:

- .1 1.6 mm (16 ga.) thick steel body zinc plated after manufacture,
- .2 chain secured neoprene expansion plug with cam lock handle,
- .3 28 mm (1 in) minimum inside diameter, length to suit insulation thickness,
- .4 Neoprene mounting gasket: flat for rectangular duct and moulded for round duct.

Standard of Acceptance

- Duro-Dyne - fig. TH1 or IP2

- .5 sealant for test port: high temperature silicone.

Standard of Acceptance

- Duro-Dyne - fig. Red High Temperature Silicon

3 EXECUTION

3.1 Flexible Connections

- .1 Provide to isolate air handling equipment, fans, ductwork, and as shown.
- .2 Minimum length: 75 mm (3 in) length of fabric measured in direction of air flow,
- .3 Minimum distance between metal parts when system is in operation: 25 mm (1 in).
- .4 Anchored on static side of connection.

3.2 Sealant and Tape

- .1 Apply to ductwork joints and seams as detailed in other sections.

3.3 Access Doors

- .1 Install in ductwork;
 - .1 before and after reheat coils, and at
 - .2 fire dampers,
 - .3 duct smoke detectors,
 - .4 volume control devices, and
 - .5 control elements.
- .2 Weld door frames in place for plenums, casings, and high velocity ductwork.
- .3 Door sizes:
 - .1 as large as possible, with 1:1.5 aspect ratio, for duct sides up to and including 360 mm (14 in),
 - .2 300 mm x 380 mm (12 in x 15 in) for duct sides 380 mm (15 in) and larger,
 - .3 1500 mm (60 in) high by 450 mm (18 in) wide in casings and plenums.

3.4 Instrument Test Ports

- .1 Install for duct velocity traverse readings and for duct air temperature readings.
- .2 Locate across duct or plenum at right angles to flow, at not more than 250 mm (10 in) intervals for traverses and at not more than 500 mm (20 in) for temperature measurements.
- .3 Install for velocity traverses;
 - .1 at ducted inlets to roof and wall exhausters,
 - .2 at inlet to and outlet from other fan systems, and
 - .3 at main and branch where branch serves more than one outlet. Ports in main to be upstream of branch in both diverging and converging flow.
- .4 Install for temperature measurement;
 - .1 at outside air intakes,
 - .2 at inlet and outlet of coils, and
 - .3 downstream of intersection of converging air streams of different temperatures.

END OF SECTION

MANUAL BALANCING DAMPERS

23 33 13.11

1 GENERAL

1.1 Scope

- .1 Provide manual balancing dampers.
- .2 This section does not apply to dampers installed in kitchen grease exhaust duct systems.

2 PRODUCTS

2.1 Splitter Dampers

- .1 Shop-fabricated, single thickness construction, of same material as duct but one sheet metal gauge thickness heavier where both dimensions of damper blade are less than 300 mm (12 in).
- .2 Double thickness construction, one metal gauge thickness lighter than duct, where either dimension of damper blade is 300 mm (12 in) or larger,
- .3 Height equal to full depth of branch duct, and length 1½ times branch duct width.
- .4 Fitted with piano hinge pivot, control rod, and locking device accessible from outside fitting.

2.2 Single Blade Dampers in Rectangular Ductwork

- .1 Manufactured product.
- .2 Blades and shaft:
 - .1 constructed of same material as the duct, with longitudinal V-grooves,
 - .2 blade thickness: 1.0 mm (20 ga.) minimum,
 - .3 blade length: 915 mm (36 in) maximum.
 - .4 bronze bearings,
 - .5 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
 - .1 channel section of same material as duct, minimum 1.3 mm (18 ga.) thickness,
 - .2 angle blade stop.

Standard of Acceptance

- ° Nailor - fig. 1870
- ° Ruskin
- ° Greenheck

2.3 Multi-Blade Dampers in Rectangular Ductwork

- .1 Manufactured product.
- .2 Blades and shaft:
 - .1 constructed of same material as the duct, with longitudinal V-grooves,
 - .2 opposed blade configuration, with link assembly located out of airstream,
 - .3 blade thickness: 1.6 mm (16 ga.) minimum,

- .4 blade height: 150 mm (6 in) maximum,
 - .5 blade length: 1200 mm (48 in) maximum.
 - .6 synthetic polymer or bronze bushings,
 - .7 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
- .1 channel section of same material as duct, minimum 1.6 mm (16 ga.) thickness,
 - .2 angle blade stop,

Standard of Acceptance

- Nailor - fig. 1820
- Ruskin
- Greenheck

2.4 Single Blade Dampers in Round Ductwork

- .1 Manufactured product.
- .2 Blades and shaft:
 - .1 constructed of same material as the duct,
 - .2 blade thickness: 0.86 mm (22 ga.) minimum,
 - .3 blade length: 915 mm (36 in) maximum.
 - .4 bronze bearings,
 - .5 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
 - .1 round duct section of same material as duct, minimum 0.86 mm (22 ga.) thickness, with stiffening beads,
 - .2 angle blade stop.

Standard of Acceptance

- Nailor - fig. 1890
- Ruskin
- Greenheck

3 EXECUTION

3.1 Balancing Damper Locations and Type

- .1 Provide balancing dampers in the following locations:
 - .1 at floor branches from a duct riser, use a single or multiple blade damper in the branch duct,
 - (a) where a wye-fitting is installed directly after the duct riser take-off, provide a balancing damper in each outlet branch after the wye fitting,
 - .2 for supply branch ducts that do not directly serve outlet grilles or diffusers, use a single or multiple blade damper in the branch duct,
 - .3 for exhaust or return branch ducts that do not directly serve inlet grilles, use a single or multiple blade damper in the branch duct,

- .4 for branch duct which directly serve three or more grilles or diffusers (supply, return or exhaust), use splitter damper in the take-off fitting, or use a single or multiple blade damper in the branch duct,
- .5 on the inlet to a supply air terminal unit, use a damper of the style to match the inlet duct connection to the air terminal unit,
- .6 on the outlet from a return or exhaust air terminal unit, use a single or multiple blade damper in the branch duct.
- .2 Provide other manual dampers as shown.

3.2 Access for Adjustment

- .1 Locate dampers to allow adjustment of blade position and for locking of the quadrant.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

DAMPERS - OPERATING

23 33 13.13

1 GENERAL

1.1 Scope

- .1 Provide motorized control dampers as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 25 30 13 Building Automation Actuators and Operators
 - .2 25 30 23.13 Building Automation Control Dampers

1.3 Submittals

- .1 Submit product data sheets for materials specified herein and include:
 - .1 performance charts, pressure drop vs approach velocity for range of blade angles from 0 to 90°,
 - .2 torque requirements,
 - .3 construction details.

2 PRODUCTS

2.1 Multi-Blade Dampers

- .1 Performance:
 - .1 leakage in closed position: maximum 2% of rated air flow at 500Pa (2 in wg) differential across assembly,
 - .2 pressure drop in open position: maximum 50 Pa (0.2 in wg) differential at 5 m/s (1000 fpm).
- .2 Construction:
 - .1 non-insulated dampers:
 - (a) blades: extruded aluminum or formed stainless steel interlocking blades,
 - (b) frame: extruded aluminum
 - .2 insulated dampers:
 - (a) blades: extruded aluminum interlocking double thickness insulated blades,
 - (b) frame: extruded aluminum, thermally broken,
 - .3 seals: extruded vinyl seals, and spring stainless steel side seals,
 - .4 maximum blade width: 150 mm (6 in),
 - .5 maximum blade length: 1200 mm (4 ft).
 - .6 self-lubricated bronze bearings.
 - .7 blade linkage: steel tie rods, brass pivots and steel brackets, for parallel blade and opposed blade operation as required for damper control operation.

3 EXECUTION

3.1 Damper Movement Style Selection

- .1 Blade movement type (for control function other than recirculating air handling units):
 - .1 parallel blade style for two position operation.
 - .2 opposed blade style for modulating applications.
- .2 Blade movement type for air handling units with recirculating air dampers;
 - .1 select damper type based on AHU function in accordance with the following table.

System Type	AHU Systems	Minimum Outdoor Air	Economizer Outdoor Air	Exhaust Damper	Recirculating Damper
Fixed Outdoor Air	All	Parallel	N/A	Parallel	Parallel
Air Economizer	All	Parallel	Opposed	Opposed	Opposed
Air Economizer – Enhanced	All	Parallel	Parallel	Parallel	Parallel

3.2 Installation

- .1 Secure dampers within ductwork, air handling units and at air inlets and exhaust outlets.
- .2 Caulk around frames and between multiple damper modules with UL listed silicone-free duct sealant.

3.3 Start-Up and Testing

- .1 Stroke dampers fully open and fully closed ten times. Check for free movement of damper blades. Check dampers full close along blade edge seals and end seals.

End of Section

DAMPERS - FIRE AND SMOKE

23 33 13.16

1 GENERAL

1.1 Scope

- .1 Provide fire dampers, smoke dampers, combination smoke/fire dampers, and ceiling fire stop flaps.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 13.16 Wiring Requirements for Mechanical Services

1.3 Definitions

- .1 The following definitions apply for this specification section:
 - .1 **Damper:** means a smoke damper, motorized fire damper or combination smoke/fire damper.
 - (a) **Balancing damper:** : a damper with an electric actuator that is listed for operation as a modulating damper in normal service, to allow setting the damper at a position between open and closed, for system air balancing purposes.
 - (b) **Dynamic damper:** a fire damper rated to close with airflow through damper at specified air velocities and operating pressure.
 - (c) **Modulating damper:** a damper with an electric actuator that is listed for operation as a modulating damper in normal service, to allow modulating control of the damper in response to a normal (non-emergency) process control requirement.
 - (d) **Reopenable damper:** a motorized fire damper or combination smoke/fire damper that can be electrically re-opened by bypassing the primary heat detection device.
 - (e) **Static damper:** a fire damper rated only to close with essentially no airflow through the damper.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 NFPA 80 Installation, Testing, and Maintenance of Fire Dampers
 - .2 NFPA 105 Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives
- .2 Product standards:
 - .1 AMCA 500-D Laboratory Methods of Testing Dampers for Ratings.
 - .2 ANSI/CAN/UL/ULC 33 Heat Responsive Links for Fire-Protection Services
 - .3 CAN/ULC - S112 Standard Method of Fire Test of Fire Damper Assemblies
 - .4 CAN/ULC - S112.1 Standard for Leakage Rated Dampers for Use in Smoke Control Systems
 - .5 CAN/ULC - S112.2 Standard Method of Fire Test of Ceiling Firestop Flap Assemblies
 - .6 ULC-S505 Standard for Fusible Links for Fire Protection Services
 - .7 CSA C22.2 No. 14 Industrial Control Equipment

1.5 Submittals

- .1 Submit manufacturer catalogue cut-sheets for the following materials;
 - .1 fire dampers,
 - .2 smoke dampers,
 - .3 combination smoke and fire dampers,
 - .4 motorized fire and smoke damper control accessories,
 - .5 fire stop flaps.
- .2 When requested by an AHJ for building safety, submit confirmation data that the fusible link is listed to ULC-S505 or ANSI/CAN/UL/ULC 33.

2 PRODUCTS

2.1 General

- .1 Approvals:
 - .1 Fire dampers and combination smoke/fire dampers listed to CAN/ULC-S112.
 - .2 Smoke dampers and combination smoke/fire dampers listed to CAN/ULC-S112.1.
 - .3 Ceiling fire stop flaps listed to CAN/ULC-S112.2.
 - .4 Fusible links for fire dampers listed to ULC-S505 or ANSI/CAN/UL/ULC 33.

2.2 Fire and Smoke Dampers - General Requirements

- .1 Curtain damper styles:
 - .1 Type A: blade pack and frames in airstream,
 - .2 Type B: blade pack out of airstream,
 - .3 Type C:
 - (a) blade pack and frame out of airstream,
 - (b) for rectangular, round and flat oval ductwork, and
 - (c) sleeve joints and damper/sleeve joints sealed.
- .2 Fire damper fire-resistance rating:
 - .1 Fire separation ratings 2 hr and less: 1-1/2 hrs.
 - .2 Fire separation rating 3 hr or more: 3 hr.
- .3 Installation orientation:
 - .1 Dynamic and static dampers suitable for installation in vertical and horizontal separations.
 - .2 Dampers that are only listed for one orientation are not permitted.
- .4 Rating class, dynamic dampers:
 - .1 Standard performance;
 - (a) air velocity, maximum 10 m/s (2000 fpm),
 - (b) operating static pressure, maximum 1000 Pa (4 in.w.c.)
 - .2 Extended performance ("EPxx");
 - (a) air velocity, maximum 15 m/s (3000 fpm),

- (b) operating static pressure, maximum 1000 Pa (4 in.w.c.)
- .3 High velocity performance ("HVxx");
 - (a) air velocity, maximum 20 m/s (4000 fpm),
 - (b) operating static pressure, maximum 1000 Pa (4 in.w.c.)
- .5 Manufacturers:

Standard of Acceptance

- Nailor
- EH Price (National Controlled Air)
- Ruskin

2.3 Fire Dampers - Curtain Type

- .1 Construction:
 - .1 Frame: G60 roll formed galvanized steel frame.
 - .2 Blades: curtain type, interlocking blades, G60 galvanized steel.
 - .3 Sleeve:
 - (a) same material as damper frame, length to suit application with steel enclosure and transition collars, and retaining angles.
 - (b) for type B damper sleeves, top of sleeve is formed closely around top of damper; sleeve construction that leaves the blade pack in the airstream is not permitted.
 - .4 Sleeve type: type A, B, or C as specified in Part 3.
 - .5 Fusible link: 71°C (160°F) unless otherwise shown.
 - .6 Notwithstanding the above, frame, sleeve, and blades to be stainless steel where damper is installed in a duct system which is stainless steel.
 - .7 Dynamic dampers: fitted with stainless steel closure spring, and rated for velocity and operating pressure based on rating class.
 - .8 Static dampers: fitted with stainless steel closure spring.

2.4 Fire Dampers - Multiblade Type

- .1 Construction:
 - .1 Type: dynamic.
 - .2 Frame: G60 galvanized steel hat channel.
 - .3 Blades: airfoil multiblade type, interlocking blades, G60 galvanized steel;
 - (a) Parallel blade for Open-Closed operation,
 - (b) Opposed blade for modulating control or balancing control.
 - .4 Blade linkage: plated steel, concealed in frame (out of airstream).
 - .5 Bearings:
 - (a) On-Off control, and balancing: self-lubricated oil-tight bronze,
 - (b) modulating control: stainless steel.
 - .6 Jackshaft: cadmium plated steel.
 - .7 Internal locking quadrant for balancing maximum opening position.

- .8 Sleeve: same material as damper frame, length to suit application with steel enclosure and transition collars, and retaining angles.
- .9 Sleeve type: type A, B, or C as per listing requirements.
- .10 Notwithstanding the above, the frame, sleeve, and blades to be stainless steel where damper is installed in a duct system that is stainless steel.
- .2 Operator - fusible link:
 - .1 Torsion spring, with 74°C (165°F) fusible link unless otherwise shown.
- .3 Operator – electric damper actuator:
 - .1 Factory installed electric damper actuator in accordance with article on Damper Actuators as required
 - (a) by certification listing for large dampers/damper bank applications, or
 - (b) where otherwise shown.
 - .2 Electric resettable heat detection switches, Normally Closed contacts opening on temperature rise above setpoint;
 - (a) setpoint temperature, non-reopenable damper: 74°C (165°F),
 - (b) setpoint temperature, reopenable damper:
 - i) primary switch: 74°C (165°F),
 - ii) secondary switch: 176°C (350°F).

2.5 Smoke Dampers

- .1 Construction:
 - .1 Type: dynamic,
 - .2 Leakage rating: Class II at 121°C (250°F)
 - .3 Frame: G60 galvanized steel hat channel, with stainless steel jamb seals,
 - .4 Blades: airfoil multiblade type, interlocking blades, G60 galvanized steel;
 - (a) parallel blade for Open-Closed operation,
 - (b) opposed blade for modulating control or balancing control.
 - .5 Blade linkage: plated steel, concealed in frame (out of airstream),
 - .6 Bearings:
 - (a) On-Off control, and balancing: self-lubricated oil-tight bronze,
 - (b) modulating control: stainless steel.
 - .7 Jackshaft: cadmium plated steel.
 - .8 Sleeve: same material as damper frame, length to suit application with steel enclosure and transition collars, caulked joints, and retaining angles.
 - .9 Sleeve type: type A, B or C as per listing requirements.
 - .10 Notwithstanding the above, the frame, sleeve, and blades to be stainless steel where damper is installed in a duct system which is stainless steel.
- .2 Operator – electric damper actuator:
 - .1 Factory installed electric damper actuator in accordance with article on Damper Actuators
 - .2 Fail Close type.

2.6 Combination Smoke and Fire Dampers

- .1 Construction:
 - .1 Type: dynamic.
 - .2 Leakage rating: Class II at 121°C (250°F)
 - .3 Frame: G60 galvanized steel hat channel, with stainless steel jamb seals.
 - .4 Blades: airfoil multiblade type, interlocking blades, G60 galvanized steel;
 - (a) parallel blade for Open-Closed operation,
 - (b) opposed blade for modulating control or balancing control.
 - .5 Blade linkage: plated steel, concealed in frame (out of airstream).
 - .6 Bearings:
 - (a) On-Off control, and balancing: self-lubricated oil-tight bronze,
 - (b) modulating control: stainless steel.
 - .7 Jackshaft: cadmium plated steel.
 - .8 Sleeve: same material as damper frame, length to suit application with steel enclosure and transition collars, caulked joints, and retaining angles.
 - .9 Sleeve type: type A, B or C as per listing requirements.
 - .10 Notwithstanding the above, the frame, sleeve, and blades to be stainless steel where damper is installed in a duct system which is stainless steel.
- .2 Operator – electric damper actuator:
 - .1 Factory installed electric damper actuator in accordance with article on Damper Actuators.
 - .2 Electric resettable heat detection switches, Normally Closed contacts opening on temperature rise above setpoint;
 - (a) setpoint temperature, non-reopenable damper: 74°C (165°F),
 - (b) setpoint temperature, reopenable damper:
 - i) primary switch: 74°C (165°F),
 - ii) secondary switch: 176°C (350°F).

2.7 Damper Actuators - Electric

- .1 Actuators listed as part of the smoke and/or fire damper assembly.
- .2 Actuators, components, wiring leads and position switches rated for 176°C (350°F).
- .3 Two-position dampers:
 - .1 Spring return, fail-safe to a closed damper position.
 - .2 Open-Closed operation, with reduced motor load at holding (open) position, allowing continuous operation at open position without overheating or overload.
 - .3 Visual position indicator.
 - .4 Motor running time (to open): maximum 30 seconds.
 - .5 Spring running time (to close): maximum 30 seconds.
 - .6 Maximum power demand (motor driving): 40 VA.
 - .7 Power supply: 120 VAC, 60 Hz.

.4 Modulating dampers:

- .1 Spring return, fail-safe to a closed damper position.
- .2 True modulating control with proportional 0-10 VDC or 4-20 mA control input (floating point control not permitted), with 2-10 VDC position feedback.
- .3 Visual position indicator.
- .4 Motor running time (to open): maximum 60 seconds.
- .5 Spring running time (to close): maximum 30 seconds.
- .6 Maximum power demand (motor driving): 30 VA.
- .7 Power supply: 24 VAC, 60 Hz.

.5 Damper position switches:

- .1 Provided as part of each actuator.
 - (a) Exception: where more than one actuator is mounted to the same damper shaft for torque rating requirements, only one actuator connected to a damper shaft is required to have the damper position switch.
- .2 Required for both two-position dampers and modulating dampers.
- .3 Integral or factory installed damper position switches;
 - (a) 2 x SPST switches, 3 A resistive rating @ 120 VAC,
 - (b) prove damper open,
 - (c) prove damper closed.

2.8 Fire Stop Flaps (Ceiling Radiation Dampers)

.1 Construction:

- .1 Galvanized steel frame and blades for round or square neck diffusers.
- .2 Fitted with corrosion resistant steel springs and replaceable 71°C (160°F) fusible link.
- .3 Supplied with thermal blanket cut to suit diffuser face plate dimensions and diffuser neck size.
- .4 Labeled or listed and rated for both steel duct and flexible duct installations.
- .5 Fitted with adjustable volume controllers where shown.

2.9 Local Damper Test Control Panel (Type “SD-1”)

.1 Construction:

- .1 Damper manufacturer accessory product.
- .2 Listed to CSA C22.2 No. 14, or conforms to applicable provincial electrical safety code for field approval or inspection.
- .3 Momentary-action, normally closed switch (pushbutton or key operated), to spring return to damper Open position.
- .4 Two damper proof-of-position indicating lights – Open and Closed.
- .5 Enclosure: NEMA 1 (minimum) or galvanized steel face-plate for mounting on standard galvanized steel 100 x 100 mm electrical junction box.
- .6 Suitable for field installation at or near the damper.
- .7 Fuse holder and overcurrent protection fuse sized to suit damper actuator power requirements.

.8 Power supply: 120 VAC.

2.10 Identification Labels

- .1 For field application to control panels.
- .2 Thermal transfer printing, 300 dpi, black lettering on white background,
- .3 Label text font height: minimum 36 point
- .4 Self-adhesive polyester tape.

Standard of Acceptance

- ° Brady

3 EXECUTION

3.1 Installation – General Requirements

- .1 Install fire dampers and fire stop flaps throughout supply, return and exhaust air systems in fire separations marked as having a fire resistance rating and as shown.
- .2 Install smoke dampers and combination smoke/fire dampers at locations as shown and as follows:
 - .1 install smoke dampers and combination smoke/fire dampers for an air-transfer opening in the plane of the fire separation,
 - .2 install duct-mounted smoke dampers and combination smoke/fire dampers:
 - (a) in the plane of the fire separation, or
 - (b) within 610 mm (24 in.) of the plane of the fire separation, provided there are no inlet or outlet grilles or diffusers between the damper and the fire separation. The distance is measured from the centerline of the damper to the closest face of the fire separation.
- .3 Install fire, smoke, and combination smoke/fire dampers in accordance with manufacturer's instructions, with sleeve, duct connections and angle supports to comply with terms and conditions of listing or classification and maintain integrity of fire wall and/or fire separation.
- .4 Install stainless steel dampers in stainless steel duct systems and/or wherever ductwork is specified to be watertight construction.

3.2 Fire Damper Selection

- .1 Select fire damper types as follows:
 - .1 "Dynamic" - all locations unless otherwise shown,
 - .2 "Static" - restricted to un-ducted transfer air openings.
- .2 Select curtain-type fire damper styles as follows:
 - .1 For dynamic and static dampers:
 - (a) duct height in the following tables is the duct dimension perpendicular to blade length orientation.

Damper Velocity Class	Duct Height mm	Curtain Damper Style
Standard Performance (≤ 10 m/s)	> 300	A
	≤ 300	B
Extended Performance	> 200	B

Damper Velocity Class (10 to \leq 12.5 m/s)	Duct Height mm	Curtain Damper Style
	\leq 200	C
High Velocity Performance ($>$ 12.5 m/s)	Any	C

Damper Velocity Class	Duct Height In.	Curtain Damper Style
Standard Performance (\leq 2000 fpm)	$>$ 12	A
	\leq 12	B
Extended Performance (2000 to \leq 2500 fpm)	$>$ 8	B
	\leq 8	C
High Velocity Performance ($>$ 4000 fpm)	Any	C

3.3 Fire Damper Installation

- .1 Where the duct size exceeds the maximum listing size of a multiple curtain damper assembly, provide multiblade fire dampers.
- .2 Where fire dampers are shown to be motorized, provide multiblade fire damper with electric operator.

3.4 Damper Sleeves

- .1 Provide factory-made damper sleeves in accordance with damper listing requirements, and as described herein.
- .2 For multiblade dampers, smoke dampers, and combination smoke/fire dampers, fabricate sleeve style based on damper size listing requirements.
- .3 Install damper sleeves with retaining angles in accordance with the damper manufacturer instructions.
- .4 Where permitted by the damper manufacturer installation instructions, smoke dampers may be fastened directly to the duct without requiring the use of a sleeve.

3.5 Damper Access Doors

- .1 Provide duct access door at each fire damper to permit visual inspection and replacement of fusible link. Do not locate access doors in a vertical service space (shaft).
- .2 Provide duct access door at each smoke damper and combination smoke/fire damper, to permit visual inspection and service of fire detection/actuation mechanism. Provide such access doors even where dampers are provided with electrically supervised damper position indication.
- .3 For curtain-type fire dampers in vertical ducts, the preferred access location is from the floor above the damper.
- .4 For motorized fire dampers, smoke dampers and combination smoke/fire dampers installed in vertical ducts, position the damper actuator assembly so that it is not located in a vertical service space (shaft). Preferred position in order of priority and applicability are:
 - .1 above floor level in a service room,
 - .2 in the ceiling space below the bottom of a vertical service space.

- .5 Install damper actuator assemblies on the room side of a damper isolating the room from a corridor, except where the duct ends at a wall grill.

3.6 Fire Stop Flap Installation

- .1 Install fire stop flaps in accordance with manufacturers' instructions. Position supplied thermal blankets to cover ceiling diffusers.

3.7 Damper Power Supplies; Controlled Dampers

- .1 This article applies to smoke dampers and combination smoke/fire dampers. This article also applies to motorized fire dampers identified on drawings as ("MFD") which are required to be controlled by the building automation system or the fire alarm system.
- .2 Power supply to these damper actuators is provided by Division 26.

3.8 Damper Power Supplies; Non-Controlled Dampers

- .1 This article applies to fire dampers requiring electric actuators due to the limitations of damper size in accordance with each manufacturer product listing, but are otherwise not remotely controlled.
- .2 Where a multiblade fire damper assembly requires an electric actuator because of limitations of its listing but not otherwise designated as a motorized fire damper ("MFD"), provide power and conduit in accordance with the requirements of specification section 20 05 12 except/and as otherwise specified herein:
 - .1 feed dampers from the nearest normal-designated 120 VAC power distribution panel,
 - .2 non-fire rated conductors may be used,
 - .3 provide 15 A breaker, with tamper lock, for each circuit,
 - .4 provide fuse protection for each actuator, sized as recommended by damper/actuator manufacturer installation instructions,
 - .5 maximum actuator load on each electrical circuit: 10 A,
 - .6 wiring and conduit:
 - (a) in accordance with specification section 20 05 12, and
 - (b) No. 14 AWG conductor size.
 - .7 each electrical circuit only to serve dampers located on the same floor (and same portion of a floor area if applicable) as the power distribution panel.

3.9 Local Damper Test Control Panel Installation (Type "SD-1")

- .1 Unless otherwise shown, install damper test control panel (Type "SD-1") in close proximity of the applicable damper, and mounted as follows:
 - .1 on the wall immediately above an accessible ceiling, behind a wall-access panel located just below the ceiling. Behind a lockable wall access panel located at 1500 mm (5 ft) above the floor, or
 - .2 wall mounted in a janitors closet or service room, located with LDTCP centerline at 1500 mm above the floor level.
- .2 Mounting the damper test control panel at the smoke damper is not permitted, except when authorized on a case-by-case basis by the Engineer.
- .3 Provide an identification label on each test switch, identifying the smoke damper, motorized fire damper or combination smoke/fire damper by the duct service (supply, return, exhaust) and room or space served.

3.10 Identification

- .1 Provide an identification label on each damper interface control panel, identifying the damper(s) by the duct service (supply, return, exhaust fan number) and room or space served. Coordinate with the supplier of any damper interface control panel to provide matching labeling.

3.11 Testing

- .1 Conduct installation tests of all fire dampers, smoke dampers, and combination smoke/fire dampers in accordance with NFPA 80, NFPA 90A and NFPA 105 as applicable to damper type and summarized as follows.
- .2 Field test all fire dampers, smoke dampers, combination smoke/fire dampers and fire stop flaps as follows:
 - .1 operate dampers to demonstrate unobstructed operation of the damper from open-to-close-to open state. These tests are to be performed while the fan systems are not in operation (static test),
 - .2 for dynamic dampers, confirm air velocity through the open dampers under normal HVAC system operation, once air balancing is completed. Select dampers to confirm operation for ducts operating within 80% of the maximum air velocity of the damper listing,
 - .3 confirm accessibility to components of fire damper to permit maintenance and testing,
 - .4 where a damper is provided with an indicating device, confirm device functions and annunciates to the supervised location or system when the damper is in both the open and closed state, as applicable.
- .3 In addition, for multiblade fire dampers with electric operators, smoke dampers or combination smoke/fire dampers, cycle test dampers under normal HVAC operating conditions (dynamic test).
- .4 Record test results as per the attached test form or similar containing the same information, and submit to Owner and Consultant as part of the Operations and Maintenance manual.
- .5 Upon completion of testing, provide labour and resources necessary to conduct a demonstration re-test for up to 10% of curtain-type dampers on each floor as selected and witnessed by Engineer.
- .6 Upon completion of testing, provide labour and resources necessary to conduct a demonstration re-test of 100% of all motorized fire dampers, smoke dampers and combination smoke/fire dampers. This test may be combined as part of the demonstration test of a smoke control system or a smoke exhaust system used to air fire fighters.

3.12 Standard Details

- .1 Refer to the following standard detail for wiring of dampers with type SD-1 local test control panel.

23 33 15-011	Fire & Smoke Damper Control Wiring / Non-Reopenable / With Local Test (Type SD-1)
--------------	---

3.13 Test Form

- .1 Test form follows at the end of this section.



Fire, Smoke, and Fire/Smoke Damper Test Record

Project							System		
Testing Company							Technician Name		
Damper location	Inspection Date YYYY-MM-DD	Damper Type ⁽¹⁾	Static Op. Test ⁽²⁾	Dyn Op. Test ⁽³⁾	Access Test ⁽⁴⁾	Air Flow ⁽⁵⁾	Confirmed/ Deficiencies	Deficiency Corrected	Damper Audited

(1) Damper Type : FD, MFD, SD, or CSFD
(2) Static Operating Test without airflow
(3) Dynamic Operating Test with balanced airflow; multiblade FD, SD and CSFD only.
(4) Damper and components are accessible for inspection and testing
(5) Identify which damper air velocity is checked in accordance with the test selection criteria.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

BACKDRAFT DAMPERS

22 33 13.23

1 GENERAL

1.1 Scope

- .1 Provide gravity and counterbalanced backdraft dampers.

2 PRODUCTS

2.1 Backdraft Dampers – Gravity and Counterbalanced Types

- .1 Performance:
 - .1 medium duty: 7.5 m/s (1500 fpm) airflow velocity,
 - .2 heavy duty: 12.5 m/s (2500 fpm) airflow velocity,
 - .3 gravity damper: for vertical (upward airflow) or horizontal duct orientation.
 - .4 counterbalance damper: for vertical (either direction) or horizontal duct orientation.
- .2 Blades and shaft:
 - .1 extruded aluminium blades with extruded PVC blade seals,
 - .2 blade thickness: 1.0 mm (20 ga.) minimum,
 - .3 blade length: 915 mm (36 in) maximum.
 - .4 concealed blade linkage in unit frame,
 - .5 synthetic polymer or bronze bearings,
 - .6 shaft extension with locking quadrant with 50 mm (2 in.) stand-off bracket.
- .3 Frame:
 - .1 50 mm (2 in.) minimum width, reinforced mitred-corner aluminium frame,
 - .2 channel section of same material as duct, minimum 1.3 mm (18 ga.) thickness,
 - .3 front and rear duct flanges with bolt holes,
 - .4 aluminium insect screen where shown,
 - .5 angle blade stop.
- .4 Gravity damper:
 - Standard of Acceptance*
 - Nailor - fig. 1370 (medium duty), 1380 (heavy-duty)
 - Ruskin
 - Greenheck
- .5 Counterbalance damper:
 - .1 As specified above for gravity dampers and with adjustable counter balance weights.

Standard of Acceptance

- Nailor - fig. 1370CB (medium duty), 1380CB (heavy-duty)
- Ruskin

- Greenheck

3 EXECUTION

3.1 Backdraft Damper Location and Type

- .1 Install gravity backdraft dampers;
 - .1 at exhaust fans not equipped with motorized dampers,
 - .2 and as shown.
- .2 Install counterbalanced backdraft dampers;
 - .1 for pressure relief of stairwell pressurization fan systems,
 - .2 and as shown.

END OF SECTION

FLEXIBLE DUCTS

23 33 16

1 GENERAL

1.1 Scope

- .1 Provide flexible ductwork as shown.

1.2 Applicable Codes and Standards

- .1 Product standards:
 - .1 ULC S110 Fire tests for air ducts.
 - .2 ULC 181 Factory made air ducts and connections.
 - .3 NFPA 90A Installation of air conditioning and ventilating systems.
 - .4 NFPA 90B Installation of warm air heating and air conditioning systems.
 - .5 SMACNA Flexible duct installation standards

1.3 Submittals

- .1 Submit manufacturer's data sheets for each product showing;
 - .1 Thermal properties.
 - .2 Friction loss characteristics,
 - .3 Acoustical loss factors,
 - .4 Leakage rates,
 - .5 Fire rating.

2 PRODUCTS

2.1 Flexible Ductwork

- .1 General requirements:
 - .1 maximum working pressure: 1.5 kPa (6 in wg),
 - .2 maximum negative working pressure: 1.25 kPa (5 in.wg.)
 - .3 pressure drop coefficients as listed below based on sheet metal duct pressure drop coefficient of 1.00,
 - .4 flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.
 - .5 Listed to ULC-S110 as a Class 1 product.

Standard of Acceptance

- Flexmaster
- Peppertree Air Solutions Inc
- Trans Continental Equipment

2.2 Metallic Flexible Ducts

- .1 Construction:
 - .1 spiral wound flexible aluminum with interlocked seams,

- .2 maximum pressure drop coefficient: 3,
- .3 airtight.

2.3 Metallic Insulated Flexible Ducts

- .1 Construction:
 - .1 spiral wound flexible aluminum with interlocked seams,
 - .2 factory applied flexible glass fibre thermal insulation with vapour barrier and vinyl or aluminum jacket, maximum "U" value of 1.25 W/m²/K (0.22 Btu/hr/sq.ft/°F),
 - .3 maximum pressure drop coefficient: 3,
 - .4 airtight.

2.4 Nonmetallic Flexible Ducts

- .1 Construction:
 - .1 coated mineral base fabric type helically supported by steel wire,
 - .2 maximum pressure drop coefficient: 3,
 - .3 airtight.

2.5 Nonmetallic Insulated Flexible Ducts

- .1 Construction:
 - .1 coated mineral base fabric type helically supported by steel wire with factory applied flexible glass fibre thermal insulation with vapour barrier and vinyl or aluminum jacket, maximum "U" value of 1.25 W/m²/K (0.22 Btu/hr/sq.ft/°F),
 - .2 maximum pressure drop coefficient: 3,
 - .3 airtight.

2.6 Sealing Compound

Standard of Acceptance

- Durodyne
- Transcontinental Equipment
- Dyn Air

3 EXECUTION

3.1 Duct Installation

- .1 Length of flexible duct feeding ceiling outlet: 1.5 to 2 m (5 to 6 ft)
- .2 Length of flexible duct feeding return/exhaust grilles: 1.5 to 2 m (5 to 6 ft).
- .3 Do not install flexible duct on exhaust grilles serving high humidity spaces including shower rooms, bathing rooms, pools, equipment process rooms, cold rooms with temperatures below 15°C (60°F), kitchens including clean-up areas, and central sterile processing areas.
- .4 Provide flexible duct and make connections to supply diffusers and grilles as shown. Do not use flexible duct connectors on return or exhaust air grilles unless shown.

- .5 Use sealing compound and tape at connection points between sheet metal and flexible duct. Make a further mechanical connection using sheet metal screws.
- .6 Centre-line radius of bends in flexible ductwork to be greater than one duct diameter.
- .7 Do not install flexible ductwork through floors, partitions or masonry walls.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

DUCT SILENCERS 23 33 19

1 GENERAL

1.1 Scope

- .1 Provide sound attenuation as shown in accordance with ASTM E477, ASTM E90 and ASTM C423, selected to maintain noise levels in areas of building as follows:

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
- open plan	36 to 38
-business machine areas	40 to 42
-conference/boardrooms	30 to 32
Operating Rooms	25 to 27
Private Bedrooms	26 to 28
Hospital Wards	30 to 32
Public Areas	38 to 40

1.2 Applicable Codes and Standards

- .1 Product standards:
- .2 ASTM E477 Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Material and Prefabricated Silencers
- .3 ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- .4 ASTM C423 Standard Test method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- .5 ASTM C 739 Standard Specification for Cellulosic Fiber Loose-fill Thermal Insulation
- .6 ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .7 Sheet Metal and Air Conditioning Contractors National Association (SMACNA) material and fabrication specifications.

1.3 Submittals

- .1 Provide shop drawing or product data sheet for each piece of attenuation equipment.
- .2 Provide performance rating data on silencers and acoustic plenums, certified by Professional Engineer and supported by test results in accordance with referenced standards as follows
- .1 Silencer; Insertion loss, pressure drop.
- .2 Acoustic plenums; Transmission loss and acoustical absorption.

2 PRODUCTS

2.1 Acoustic Plenums and Panels

.1 Manufacturers:

Standard of Acceptance

- Vibro-Acoustics
- Vibron
- Korfund
- IAC

.2 Panels:

- .1 tongue and groove connection type, with individual panels removal for equipment access,
- .2 outer sheet of 1.3 mm (18 ga) thick galvanized steel to ASTM A653, with coating designation Z90,
- .3 inner sheet of 0.8 mm (22 ga) thick galvanized steel to same specification with 2 mm (3/32 in) diameter perforations on 5 mm (3/16 in) staggered centres,
- .4 edge frame made up with 1.3 mm (18 ga) galvanized steel channels,
- .5 horizontal stiffeners of 0.8 mm (22 ga) minimum galvanized steel on 800 mm (32 in) centres.

.3 Access panels:

- .1 sized for equipment removal,
- .2 two handles per panel and machine screws around perimeter at 100 mm (4 in) maximum centres,
- .3 perimeter neoprene sponge gasket.
- .4 constructed as specified above for standard panel.

.4 Access doors:

- .1 minimum 510 mm x 1375 mm (20 in x 54 in) opening,
- .2 constructed as specified for standard panel except with interior sheet unperforated.
- .3 perimeter neoprene sponge gasket,
- .4 zinc plated hardware; two butt type nylon bushed hinges and two cam type latches with inside and outside handles,
- .5 opening against direction of air flow.

.5 Inspection windows:

- .1 minimum 310 mm x 310 mm (12 in x 12 in) opening,
- .2 double glazed with 6 mm (¼ in) wire reinforced glass mounted in neoprene 'U' channels.

.6 Plenum assembly:

- .1 stiffened to limit deflection to 1/200th of span when subjected to pressure differential equal to fan shut off static pressure.
- .2 fabricated with base sections and flashing of 1.3 mm (18 ga) minimum galvanized steel.
- .3 externally sealed at panel and flashing joints with 5 mm (3/16 in) diameter bead of elastomeric sealant.

- .4 sealed between floor channel and floor connection with 3 mm x 13 mm (c in x ½ in) monolastic tape.
- .7 Openings in panel assembly:
 - .1 factory cut and framed where greatest dimension exceeds 310 mm (12 in),
 - .2 located and cut on site where greatest dimension is less than 310 mm (12 in),
 - .3 cut 50 mm (2 in) larger than pipe or conduit and sleeved with 0.8 mm (22 ga) minimum galvanized steel, with
 - .4 space between pipe or conduit and sleeve or frame to be filled with acoustic media, covered and sealed.
- .8 Plenum performance:
 - .1 Assembly RSI to be not less than 1.2 (m².° C)/W at 10° C.
 - .2 Certified acoustical transmission loss to ASTM E90 and acoustical absorption to ASTM C423 to be in accordance with following table.

	Octave bands (Hz)					
	125	250	500	1k	2k	4k
Transmission loss, db	21	28	39	50	53	56
Absorption coefficient	0.7	0.9	0.99	0.99	0.9	0.9

2.2 Absorption and Insulating Media

- .1 Material:
 - .1 acoustic quality, 100% natural cotton fibre treated with EPA registered, flash dried nontoxic borate solution. Glass fibre, free of shot and odour.
 - .2 bacteria and fungus resistant.
 - .3 free of corrosion causing or accelerating agents.
 - .4 minimum density of 72 kg/m³ (4.5 lb/ft³) when packed under 10% compression.
 - .5 in accordance with Code fire requirements for duct lining.

2.3 Silencers

- .1 Factory manufactured of galvanized or prime painted steel, meeting SMACNA material standards.
- .2 Construction:
 - .1 0.8 mm (22 ga) minimum outer shell with airtight mastic filled seams for rectangular low velocity applications up to 10 m/s (2000 fpm),
 - .2 1.6 mm (16 ga) welded outer shell for rectangular high velocity application over 10 m/s (2000 fpm) and for circular units 600 mm (24 in) diameter and larger,
 - .3 1.2 mm (18 ga) welded outer shell for circular units of less than 600 mm (24 in) diameter,
 - .4 50 mm (2 in) slip connections, and lifting lugs, and
 - .5 acoustic media.
- .3 Fittings:

- .1 inner casing minimum 0.8 mm (22 ga) perforated metal, enclosing acoustic media, and
- .2 media erosion protection of mold resistant cloth between media and perforated metal, where airflow gap velocity exceeds 22.5 m/s (4500 fpm).

Standard of Acceptance

- Vibro-Acoustics
- Vibron
- Korfund
- IAC

2.4 Cross-talk Silencers

- .1 Factory manufactured of galvanized or prime painted steel, meeting SMACNA material standards.
- .2 Construction:
 - .1 0.8 mm (22 ga) outer casing,
 - .2 0.6 mm (24 ga) perforated inner galvanized metal facings,
 - .3 75 mm (3 in) slip connections, and
 - .4 acoustic media.

Standard of Acceptance

- Vibro-Acoustics
- Vibron
- Korfund
- IAC

3 EXECUTION

3.1 Installation

- .1 Install sound attenuation equipment in accordance with manufacturer's instructions

3.2 Floating Floors

- .1 General:
 - .1 provide reinforced floating concrete slabs where shown.
 - .2 pour slabs in sections not exceeding 15 m (50 ft) in any direction.
 - .3 butt formwork together with 13 mm (½ in) ply clips and cover with two layers of 0.152 mm (6 mil) thickness polyethylene overlapped 150 mm (6 in) and taped.
 - .4 isolate from side walls with 25 mm (1 in) rigid glass fibre sealed with caulking compound.
 - .5 support panels for floating floor sections on 50 mm (2 in) thick isolator pads, bonded to 20 mm (¾ in) plywood.
- .2 Services isolation:
 - .1 isolate pipes, ducts and conduits passing through floating floor.
 - .2 provide moulded neoprene isolators at penetrations.

Standard of Acceptance

- Vibro-Acoustics
- Vibron
- Korfund

3.3 Manufacturer's Inspection

- .1 On completion of installation and start-up of equipment;
 - .1 make arrangements for manufacturer/supplier of Sound Attenuation equipment to visit site, check performance of noise attenuation systems, inspect installation and submit written recommendations.
 - .2 make corrections to installation in accordance with manufacturer/suppliers recommendations.
 - .3 provide notice 24 hours in advance of this site visit.

3.4 Testing

- .1 Engage and pay for an experienced sound and vibration professional to take measurements of sound generated by HVAC systems.
- .2 Co-operate with manufacturer/supplier of Vibration Isolation equipment in this measurement and testing.
- .3 Sound measurements to extend over full audio frequency range and to be taken in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and main electrical rooms.
- .4 Submit outline of tests to be performed, details of instrumentation to be used and floor plans showing test locations prior to commencing work.
- .5 Provide notice one week in advance of commencement of tests.
- .6 Submit complete report of tests addressing noise levels measured in occupied areas and adequacy of Sound Attenuation and Vibration Isolation equipment.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

LOUVRES

23 33 63

1 GENERAL

1.1 Scope

- .1 Louvres are provided under General Trades scope of work.

1.2 Submittals

- .1 Submit manufacturer's data sheets for wall louvres with model numbers, design data, support and anchor details and outline dimensions.

2 PRODUCTS

2.1 Not used

3 EXECUTION

3.1 Installation

- .1 Confirm opening size and co-ordinate location of louvres with other Trades.
- .2 Where blank-off openings at back of louvre are oversized, install 1.2 mm (18 ga) reinforced galvanized sheet steel blank-offs, sealed with fire resistant mastic between galvanized steel and aluminum.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

HVAC FANS

23 34 16

1 GENERAL

1.1 Scope

- .1 Provide centrifugal and axial HVAC fans of type, size and performance as shown.
- .2 Include labour and material to change pulleys and belts on all fans.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 01 Basic Materials and Methods
 - .2 20 05 13 Common Motor Requirements for Mechanical Equipment.
 - .3 20 05 49 Seismic Restraint

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 ABMA 9 Load Ratings and Fatigue Life for Ball Bearings
 - .2 ABMA 11 Load Ratings and Fatigue Life for Roller Bearings
 - .3 AMCA 99 Standards Handbook
 - .4 AMCA 204 Balance Quality and Vibration Levels for Fans
 - .5 AMCA 205 Energy Efficiency Classification for Fans
 - .6 AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
 - .7 AMCA 211 Certified Ratings Program – Product Rating Manual for Fan Air Performance
 - .8 AMCA 300 Reverberant Room Method for Sound Testing of Fans,
 - .9 AMCA 311 Certified Ratings Program – Product Rating Manual for Fan Sound Performance
 - .10 AMCA 320 Laboratory Methods of Sound Testing Fans Using Sound Intensity
 - .11 ASME B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

1.4 Design Criteria

- .1 Fan rating conditions:
 - .1 elevation: project site elevation-based.
 - .2 airflow design temperature:

Application	Temperature
Conditions supply air fans	10°C (50°F)
Suppl air and make-up air fans (with upstream heating)	21°C (70°F)
Supply air or make-up air fans	-25°C (-13°F)

Application	Temperature
(no heating or heating is downstream of fan)	
Conditioned space return air or exhaust air fans	21°C (70°F)
Process exhaust fans	21°C (70°F)
Parking garage exhaust fans	-25°C (-13°F)
Other fans unless otherwise shown on equipment schedules	21°C (70°F)

1.5 Seismic Qualification

- .1 Seismically qualify (certify) fans (excluding motors) used for smoke control or smoke venting, including dedicated and non-dedicated fans used for this purpose, to remain operational after being subjected to the design seismic forces assuming a building height factor (NBCC) $A_x = 3.0$ with equipment flexibly mounted, by the shaker table method in accordance with Specification section 20 05 49.

1.6 Submittals

- .1 Submit product data sheets for materials specified herein. Submittals to include:
 - .1 Dimensioned standard drawings indicating dimensions, motor mounting details, inlet and outlet connection details, and equipment weight,
 - .2 motor ratings and characteristics,
 - .3 drive arrangements including drive-set details,,
 - .4 AMCA certified performance curves for each fan showing airflow, static pressure, efficiency point, fan RPM, and power input as KW (brake horsepower) from shut-off to free delivery through scheduled rating point, and also show fan curves for fan RPM at 15% above and 15% below this curve.
 - .5 certified sound power data for supply, return and exhaust fans.
 - .6 specified accessories.
- .2 Operating and maintenance data:
 - .1 provide operation and maintenance data for incorporation into operating and maintenance manuals,
 - .2 include factory test vibration analysis report for fans with motor power ratings greater than 15 kW (20 hp).

1.7 Quality Control

- .1 Fan performance for airflow rate, fan pressure, fan power, air density, fan RPM and fan efficiency: certified and bear the AMCA seal to AMCA Publication 211 when tested in accordance with AMCA Standards 210.
- .2 Fan acoustic performance: certified and bear the AMCA seal to AMCA Publication 311 when tested in accordance with AMCA Standard 300 or AMCA Standards 320.
- .3 Fan energy efficiency: rated in accordance with AMCA Standard 205.
- .4 Fan vibration: factory vibration tested prior to shipment as a completed assembly, in accordance with AMCA Standard 204 and as follows:
 - .1 tested at the specified fan RPM,

- .2 vibration signature measured at each fan bearing in the horizontal, vertical and axial directions,
- .3 maximum allowable fan vibration level: grade G6.3 to AMCA Standard 204, at 3.8 mm/s (0.15 in/sec) peak velocity, filter-in, with the fan rigidly mounted,
- .4 vibration test records are to be retained by the manufacturer and copies to be made available to the Owner on request.

2 PRODUCTS

2.1 General

- .1 Space allocation, motor sizes, base details, connection arrangements and performance are based on fan equipment by manufacturers as shown in schedules.
- .2 Fans to be of same manufacture for similar applications, but may be chosen from other manufacturers' product lines for other different applications, and are to be selected from manufacturer's catalogued range of standard products.

Standard of Acceptance)

- New York Blower (Northern Industrial Supply)
- Barry Blower/Pennbarry)
- Chicago Blower
- CML Northern Blower
- Trane
- Greenheck
- Loren Cook
- Twin City
- Industrial Air
- Woods
- Carnes
- Acme

2.2 Selection Criteria

- .1 Select fan size, operating RPM and rating point on stable part of head flow curve with smooth characteristics.
- .2 Except as specified elsewhere in this Section, select fans (excluding motors) so that the fan construction will permit fan operation up to 125% of the design static pressure and airflow rate, individually and concurrently, without requiring modifications to this equipment.

2.3 Construction General Requirements

- .1 Fan class to conform with AMCA 99-2408, Operating Limits for centrifugal fans.
- .2 Fan housing and impeller:
 - .1 statically and dynamically balanced impeller,
 - .2 operating at least 20% below first critical speed when operating at maximum speed for class of construction,
 - .3 continuously welded steel housing, unless other materials are shown, with integral reinforcing bracing, and spun inlet cones,
 - .4 pre-punched flanges for ductwork connections,

- .5 interior and exterior surfaces factory cleaned and primed with zinc-rich coating, and finished in manufacturers standard top coat,
 - (a) where shown on equipment schedules, coatings for surfaces contacting airstream: Heresite coated for carbon steel materials.
 - (b) coating performance to meet 1000 hour salt spray test in accordance with ASME B117.
- .3 Fan shaft:
 - .1 steel shaft, turned, ground and polished, and protected with a petroleum-based rust preventative coating,
 - .2 sized for first critical speed at a minimum of:
 - (a) 1.25 times maximum speed for fan Class I and II, and
 - (b) 1.40 times maximum speed for fan Class III and IV.
 - .3 key shaft to the wheel hub,
- .4 Fan bearings:
 - .1 grease lubricated self-aligning ball or roller type with oil retaining, dust excluding seals,
 - .2 cartridge type for shafts less than 37 mm (1 - 7/16 in) diameter,
 - .3 shaft adapter sleeves with horizontally split pillow blocks and mechanical flinger type grease valves for shafts 37 mm (1 - 7/16 in) diameter or larger,
 - .4 interference fit rather than adapter sleeve type on shafts 56 mm (2 - 3/16 in) and larger
 - .5 furnished with drain plugs,
 - .6 fitted with extended grease lubricating lines where access is restricted,
 - .7 packed with grease at factory,
 - .8 chosen for 125% of rotational speed at point of selection, and with an L₁₀ service life rating of 100,000 hours in accordance with ABMA 9 or ABMA 11.
- .5 Fan configuration (unless shown or noted otherwise):
 - .1 Arrangement #1 or #2 for single inlet, single width, belt driven fans up to and including 915 mm (36 in) wheel diameter.
 - .2 Arrangement #3 for belt driven single inlet fans with wheel diameter larger than 915 mm (36 in) diameter and belt driven double inlet fans.
 - .3 Arrangement #3 for plenum (plug) fans.
 - .4 Arrangement #10 for utility sets.
 - .5 Arrangement #8 for direct connected single inlet centrifugal fans.
 - .6 Arrangement #7 for direct connected double inlet fans.
- .6 Fan/motor drives and guards:
 - .1 pulleys and drive belts to conform to Section 20 05 01,
 - .2 guards for fan/motor belt-drive and couplings, to conform to Section 20 05 01,
 - .3 guards for fan inlet openings to conform to Section 20 05 01.
- .7 Fan motors:
 - .1 motors to conform to Section 20 05 13, except/and as specified herein,

- (a) minimum motor power rating: not less than motor kW (horsepower) shown in equipment schedules, and
- (b) capable of satisfactory operation without motor overload or operation in the motor service factor, over a performance range from shut-off to run-out at 115% of rotational speed at point of selection.

.2 motor slide rails to conform to Section 20 05 01,

2.4 Centrifugal Fans

.1 Arrangement:

- .1 rotation, discharge and motor position to be as shown,
- .2 unless otherwise shown, fan classification to be selected to permit operation at 125% of rotational speed at point of selection.

.2 Fan wheels:

- .1 backward curved or backward inclined blades for fan wheel diameters less than 686 mm (27 in), backward curved air foil blades for fan wheel diameters 686 mm (27 in) and larger.

.3 Accessories:

- .1 38 mm (1 - ½ in) casing drains where fans discharge vertically,
- .2 access doors in scroll casing,
- .3 stuffing box style shaft seals on single inlet single width fans and utility sets.

2.5 Plenum (Plug) Fans

.1 Arrangement:

- .1 rotation, discharge and motor position to be as shown, with motor mounted on frame,
- .2 unless otherwise shown, fan classification to be selected to permit operation at 125% of rotational speed at point of selection.

.2 Fan wheels:

- .1 backward curved air foil blades.

.3 Accessories

- .1 outlet cage,
- .2 inlet collar.

2.6 Cabinet Fans

.1 Construction:

- .1 single or multiple wheel DWDI centrifugal fans with motor and V-belt drive, selected in accordance with requirements for centrifugal fans,
- .2 arranged with not less than 0.75 wheel diameter clearance between fan inlet and plenum wall,
- .3 factory fabricated casing of zinc coated or phosphate treated steel of 1.6 mm (16 ga) thickness, reinforced and braced for rigidity,
- .4 removable panels for access to internal parts,
- .5 internally lined cabinet with 50 mm (2 in) thick rigid acoustic insulation,
- .6 expanded metal mesh over insulation on floor.

2.7 Utility Sets**.1 Construction:**

- .1 single inlet single width centrifugal fans selected in accordance with requirements for centrifugal fans,
- .2 light weight construction, with V-belt pulley outboard of fan bearings and motor shaft pointing in same direction,
- .3 belt-guard and motor enclosure,
- .4 weatherproof enclosure where fans are located outdoors.

2.8 Tube-axial and Vane-axial Fans**.1 Construction:**

- .1 fabricated casings of welded steel with welded motor support, hinged or bolted access doors, streamlined inlet cone and discharge bell sections,
- .2 integral silencer casing,
- .3 reinforced legs for floor mounted units,
- .4 support bracket welded to side of casing for suspended units,
- .5 direct driven wheel with adjustable pitch fan blades, totally enclosed "air-over" motor and diameter of wheel hub at least equal to that of motor frame.
- .6 belt driven wheel with adjustable pitch fan blades, externally mounted open drip proof motor, internal belt fairing, external belt guard and adjustable motor mounts for belt tensioning.

2.9 Tubular Centrifugal Fans**.1 Construction:**

- .1 constructed as for centrifugal fan wheels, with direct drive or belt drive as shown,
- .2 configured as Arrangement #1, #9, or as indicated,
- .3 smooth rounded inlet, and stationary guide vanes.

3 EXECUTION**3.1 Fan installation**

- .1 Mount fans as shown, with vibration isolation, restraining snubbers, flexible electrical leads, and flexible connections to inlet and discharge ductwork.
- .2 Align shafts, belt drive and motor, and adjust belt static tension based on measured belt deflection test in accordance with drive manufacturer instructions.
- .3 Confirm and check motor rotation before start-up.

3.2 Protection

- .1 Provide temporary enclosures for open drip proof motors.
- .2 Cover fan inlet and discharge openings during construction to prevent ingress of foreign objects into the fan housing.
- .3 Rotate fans, by hand, every month between delivery and acceptance of building.

3.3 Start-Up and Testing

- .1 During system air balancing, adjust sheaves on variable pitch belt drives, adjust blade pitch of axial flow fans, and change pulleys and belts on fixed pitch belt drives, to achieve specified air quantities.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

GRILLES, REGISTERS AND DIFFUSERS

23 37 13

1 GENERAL

1.1 Scope

- .1 Provide grilles, registers, and diffusers as shown.
- .2 Provide security diffusers and grilles as shown.

1.2 Applicable Code and Standards

- .1 Installation codes and standards:
 - .1 NPFA 90 Standard for the Installation of Air-Conditioning and Ventilation Systems
- .2 Product standards:
 - .1 ASHRAE 70 Method of Testing the Performance of Air Outlets and Air Inlets
 - .2 ASTM D610 Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
 - .3 ASTM D714 Test Method for Evaluating Degree of Blistering of Paints
 - .4 ASTM D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
 - .5 ASTM D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
 - .6 ASTM D4752 Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

1.3 Submittals

- .1 Submit manufacturer's data sheets with product data including:
 - .1 equipment model numbers, configuration, dimensions, support requirements, general assembly and materials,
 - .2 catalog performance ratings that indicate air flow, static pressure, throw distance at air velocity, and noise criteria (NC) data.

1.4 Samples

- .1 Submit examples of each type and style of diffuser and grille with sample finishes when requested by Consultant or the Owner.

2 PRODUCTS

2.1 General

- .1 Grilles, registers, and diffusers:
 - .1 product of one manufacturer where same model or type identification is used,
 - .2 performance data determined in accordance with ASHRAE 70,
 - .3 standard catalogue products selected to meet capacity, throw, and noise level,
 - .4 prime coated, stamped or cold rolled steel material with mitred corners and exposed joints welded and ground smooth,

- .5 extruded satin finish, clear anodized aluminum material with mitred corners and mechanical fasteners,
- .6 frames with full perimeter gaskets, plaster stops where set into plaster or gypsum board, and concealed fasteners,
- .7 All visible fasteners for grilles and diffuser installations shall be tamper resistant/security type.**
- .2 Materials selection and finish colour as further shown on equipment schedules.

2.2 Type Designations

- .1 Diffuser, register and grille schedule identifies model or type identifiers used on floor plans with model numbers taken from listed manufacturer's catalogue.
- .2 Where several manufacturer's model numbers are given, these are acceptable alternatives.
- .3 Where only one manufacturer's model number is given, provide designated item.

Standard of Acceptance

- E.H. Price
- Tuttle & Bailey
- Titus
- Hart & Cooley
- Carnes
- Nailor
- MetalAire

2.3 Supply Registers

- .1 Double deflection style with face bars vertical and rear bars horizontal.
- .2 Perimeter border frame with gasket.
- .3 Opposed blade dampers (OBD) with concealed manual operator.
- .4 Materials: aluminum.

2.4 Return and Exhaust Grilles

- .1 Single deflection type, with horizontal face bars, 20° maximum turn up.
- .2 Perimeter border with gasket.
- .3 Aluminum egg crate and extruded aluminum border,
- .4 Opposed blade damper (OBD) with concealed operator.
- .5 Materials: aluminum.
- .6 Provide mounting frame and concealed fasteners in gypsum board application.

2.5 Diffusers

- .1 Square plaque face type, round with adjustable pattern control and square with fixed pattern control,
- .2 Powder coated, finish colour per schedule.
- .3 Of aluminum material,
- .4 Opposed blade dampers (OBD) accessible from room side,

- .5 Provide mounting frame and concealed fasteners in gypsum board application,
- .6 Removable face plate for damper access from room side,
- .7 Provide gypsum board frames for diffuser in gypsum board ceiling

2.6 Linear Grilles

- .1 Aluminum bar core type with margin as indicated, pattern adjustment, plaster frames, sealing strips, end caps, mitred corners and alignment key strips for multiple sections.
- .2 Capable of supporting 90 kg (200 lbs) point loads where installed as floor grilles.

2.7 Security Grille and Diffuser (Maximum Security)

- .1 Maximum Security Square grille (Supply – E.H. Price MSRRG, Return – E.H. Price MSRRP),
- .2 Powder coated, finish colour per schedule.
- .3 Of steel material,
- .4 Opposed blade dampers (OBD) with concealed manual operator,
- .5 For security grilles and diffusers, mechanically fasten grille/diffuser to building structure, independent of ductwork connection or ceiling system.

3 EXECUTION

3.1 Layout

- .1 Drawings showing position of air distribution outlets are essentially diagrammatic. Coordinate exact location of diffusers with other elements in ceiling and shown on reflected ceiling drawings and select trim to suit ceiling materials listed in Finish Schedules.

3.2 Installation of Grilles and Diffusers

- .1 Install supply registers with face bars vertical and exhaust and return registers with face bars horizontal.
- .2 Install registers and grilles with oval head cadmium plated screws in countersunk holes where fastenings are visible.
- .3 Diffusers to be installed with concealed fastenings.
- .4 Round, square and rectangular diffusers to be provided with equalizing deflectors, mounted in neck, accessible from diffuser face, with blades oriented at right angles to direction from which air is flowing.
- .5 Except for last diffuser on branch, each diffuser installed in underside of supply duct to have extract volume control damper.
- .6 For maximum security grilles and diffusers:
 - .1 Place maximum security grille and sleeve in concrete formwork prior to pouring of walls. For masonry construction, set the grille/sleeve in-place at the correct location as the masonry unit work progresses.
 - .2 Secure grille/wall sleeves by field-welding the retention frame to the wall sleeve on the unsecured side of the wall. Using a continuous bead fillet weld.
 - .3 For grilles located at fire separations, install the fire damper in an out-of-plane method on the unprotected side of the wall, with slip joints attached to the grille sleeve. Provide fire-rated duct wrap around fire damper and extend insulation a minimum of 1 m (39 in.) away from the fire damper.

3.3 Special Installations

- .1 Grilles, registers and diffusers penetrating fire walls and fire partitions, to have steel sleeves secured to structure in accordance with NFPA 90A-1985.
- .2 In gymnasiums, provide safety chain on each diffuser face and core and mechanically secure the diffuser in place.
- .3 For security grilles and diffusers, and other grilles and diffusers exceeding 5 kg (12 lbs) weight, mechanically fasten grille/diffuser to ceiling or wall structure, independent of ductwork connection or support.

END OF SECTION

PARTICULATE AIR FILTERS

23 41 11

1 GENERAL

1.1 Scope

- .1 Provide particulate filters as shown, including:
 - .1 particulate air filters,
 - .2 filter holding frames,
 - .3 side-access filter housing,
 - .4 filter gauges.

1.2 Definitions

- .1 Abbreviations
 - .1 **MERV**: minimum efficiency reporting value in accordance with ASHRAE 52.2
 - .2 **HEPA**: High Efficiency Particulate Air
 - .3 **ULPA**: Ultra Low Particulate Air

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 ASHRAE 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .2 CAN/ULC-S111 Standard Method of Fire Tests for Air Filter Units.
 - .3 IEST-RC-CC001 HEPA and ULP Filters
 - .4 IEST-RC-CC021 Testing HEPA and ULPA Filter Media
 - .5 IEST-RC-CC034 HEPA and ULPA Filter Leak Tests

1.4 Submittals

- .1 Submit manufacturer's catalogue literature for filters showing:
 - .1 pressure drop vs air flow rate,
 - .2 filter efficiency rating,
 - .3 media area in each cell,
 - .4 filter dimensions,
 - .5 maximum recommended pressure drop at filter change,
 - .6 product test report including all details as prescribed in ASHRAE 52.2,
 - .7 product test report confirming filters are rated as MERV-A when tested in accordance with Appendix J of ASHRAE 52.2, at the same specified MERV rating value.

2 PRODUCTS

2.1 General Requirements

- .1 Filter efficiency performance (except HEPA and ULPA filters): certified to conform to ASHRAE 52.2 for MERV ratings and with equal MERV-A ratings as tested in accordance with Appendix J of ASHRAE 52.2.
- .2 Filters listed as a Class 2 product to CAN/ULC-S111.
- .3 Filters to be suitable for continuous exposure to air at the following conditions as applicable:

Filter Position	Minimum Air Temperature °C (°F)	Relative Humidity %RH
Before first heating coil	-25 (-13)	90%
After cooling coil	+3°C (37°F)	100%
All other locations	+3°C to 50°C (37°F to 122°F)	10% to 95%

- .1 maximum air temperature: 50°C (122°F).
- .4 Filter sizes: as shown on equipment schedules or as specified in specification sections for air handling equipment.

Standard of Acceptance

- AAF
 - Camfil
 - Airgaud (Parker)
- .5 Where filter manufacturer and models are listed herein, they represent those filters that meet the minimum specification requirements but which might not have MERV-A ratings. Where both MERV and MERV-A ratings are required, the contractor or vendor shall select products that are certified to equal MERV/MERV-A ratings.

2.2 MERV 8 – Panel Filter

- .1 Performance:
 - .1 filter style: Panel, disposable
 - .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
 - .3 filter depth: 100 mm (4 inch) , nominal
 - .4 efficiency: MERV 8 at 2.5 m/s (492 fpm)
 - .5 initial air resistance: 75 Pa (0.30 in.w.c.), maximum
 - .6 final air resistance: 250 Pa (1 in.w.c.), minimum at change out
- .2 Construction:
 - .1 media; synthetic
 - .2 frame: fibre board with moisture inhibitors
 - .3 face gasket: none.

Standard of Acceptance

- Camfil - Farr 30/30 or Aeropleat III
- AAF - fig. VP-MERV8 SC

2.3 MERV 14 – Rigid Box

.1 Performance:

- .1 filter style: Rigid-Box, disposable
- .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
- .3 filter depth: 300 mm (12 inch) , nominal
- .4 efficiency and initial air resistance:

MERV	14
Initial air resistance Pa (in.w.c.)	160 (0.64)

- .5 final air resistance: 375 Pa (1.5 in.w.c.), minimum at change out

.2 Construction:

- .1 media; glass fibre
- .2 frame: galvanized steel
- .3 face gasket: Neoprene

Standard of Acceptance

- Camfil - fig. Riga-Flo
- AAF - fig. Varicel

2.4 MERV 14 – Rigid V-Bank

.1 Performance:

- .1 filter style: Rigid V-Bank, disposable
- .2 capacity: 945 L/s at 2.5 m/s (2000 CFM at 492 fpm) @ 600 x 600 mm (24 x 24 in) filter size; prorated for other sizes.
- .3 filter depth: 300 mm (12 inch) , nominal
- .4 efficiency and initial air resistance:

MERV	14
Initial air resistance Pa (in.w.c.)	140 (0.56)

- .5 final air resistance: 375 Pa (1.5 in.w.c.), minimum at change out

.2 Construction:

- .1 filters to be cable of being fully incinerated.
- .2 media; glass fibre

- .3 frame: plastic
- .4 face gasket: Neoprene

Standard of Acceptance

- Camfil - fig. Durafil 2V, Durafil ES2
- AAF - fig. Varicel VXL

2.5 Filter Holding Frames

- .1 Construction:
 - .1 modular framing system,
 - .2 minimum 1.27 mm (18 ga) thick galvanized steel with 20 mm (3/4 in) wide filter sealing flange, pre-drilled for frame-frame fastener attachments,
 - .3 replaceable Neoprene gasket on frame face for filters not provided with integral gaskets,
 - .4 gasketing between adjacent frames and between frames and plenum walls,
 - .5 high-tensile spring clips filter-fasteners.

Standard of Acceptance

- AAF - fig. PF-1 Pureframe, Universal Holding Frames and Latches
- Camfil - fig. FastFrame (upstream filter loading)
- Camfil - fig. Type 8 Frame (downstream filter loading)

2.6 Side Access Housings

- .1 Construction:
 - .1 1.6 mm (16 ga) galvanized steel frame with Z-channel support members, with inlet and outlet mounting flanges for connection to ductwork or plenums,
 - .2 filter tracks: aluminium, with lever locking to full face of frame,
 - .3 doors: galvanized steel door, continuous or two point hinges, locking knobs, sealed with full perimeter neoprene gaskets, and seals the filter side facing the door,
 - .4 tracks and doors fully gasketed,
 - .5 50 mm (2 in) thick, double wall, insulated construction,
 - .6 capable of holding pre-filter and final filters, or separate racks for each filter bank,
 - .7 filter depth:
 - (a) 50 mm to 100 mm (2 to 4 in) for panel filters,
 - (b) 150 mm to 915 mm (6 to 26 in) for all filters

Standard of Acceptance

- AAF - fig. SureSeal (two-stage), SurePlea (panel filters)

2.7 Air Filter Gauges

- .1 Pneumatic magnehelic gauge:
 - .1 cast aluminium housing, with acrylic cover, 100 mm (4 in) diameter dial face,
 - .2 connections: NPS 1/8 NPT,

- .3 dual scale Pa, and inch water column,
- .4 0-250 Pa (0-1 in wg) range for panel filters,
- .5 0-750 Pa (0-3 in wg) range for other filter banks,
- .6 installation kit with static pressure tips and isolation valves.

Standard of Acceptance

- Dwyer - fig. 2001D, 2003D

3 EXECUTION

3.1 Filter Banks

- .1 Install in plenums, ducts, and air intakes in filter racks or filter housings as shown, where not provided as an integral part of an air handling unit.
- .2 Made up using one size of cell throughout. Mixed cells are not permitted.

3.2 Filter Gauges

- .1 Provide filter gauges at the following filter banks:
 - .1 each bank of filters over 1900 l/s (4000 cfm) capacity, and
 - .2 for each bank of HEPA and ULPA filters regardless of capacity.
- .2 Provide separate gauges for each filter bank.
- .3 Install and pipe static pressure tips and isolating valves to allow calibration of pressure gauges.

3.3 Filter Protection and Replacement

- .1 Provide temporary roughing filters ahead of filter banks during initial operation of air handling systems.
- .2 When building is turned over to the Owner;
 - .1 remove temporary filters and ensure that filter banks are fitted with full sets of filters.
 - .2 install new, full sets of filters for any air filter banks used during construction and loaded to more than 125% of initial clean pressure drop.

3.4 Inspection and Testing

- .1 Immediately prior to hand-over to the Owner,
 - .1 visually inspect the filters and filter frames to ensure there are no visible gaps in frame gaskets and blanking plates, that filters are set square and level in their frames, and retention clips are in place.
 - .2 with the air handling system operating at normal conditions, check and record the pressure drop across each filter bank, and submit a test report with the date of the test to the Owner and include in the operations and maintenance data.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

FAN COIL UNITS

23 82 19

1 GENERAL

1.1 Scope

- .1 Provide fan coil units as shown.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code
- .2 Product standards:
 - .1 AHRI 440 Performance Rating of Fan-Coil Units
 - .2 ASTM B75 Standard Specification for Seamless Copper Tube
 - .3 CSA C22.2 No. 236 Heating and Cooling Equipment
 - .4 ULC S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.3 Design Criteria

- .1 Coils to have a Canadian Registration Number ("CRN") in accordance with CSA B51.
- .2 Performance rating – heating:
 - .1 media: water
 - .2 entering water temperature: 76.8°C (170°F)
 - .3 water temperature drop (ΔT): 11.1°C (20°F)
 - .4 entering air temperature: 18°C (65°F)
 - .5 performance with fan operating at (65%)speed.
- .3 Design criteria, cooling:
 - .1 media: water
 - .2 entering water temperature: 10°C (50°F)
 - .3 water temperature rise (ΔT): 5.5°C (10°F)
 - .4 entering air temperature: 23°C (74°F)
 - .5 performance with fan operating at 65% speed.
- .4 Coil and piping design pressure: 2070 kPa (300 psi)
- .5 Acoustic performance:
 - .1 Room noise level: NC (30) maximum with fan running on low speed and with acoustically treated cabinet.

1.4 Submittals

- .1 Submit manufacturer's data sheets for fan coil units with;
 - .1 equipment model numbers,
 - .2 performance and design data,

- .3 outline dimensions and weight,
- .4 power requirements,
- .5 support and connection details.

2 PRODUCTS

2.1 General

- .1 Heating equipment capacities are as shown.
- .2 Fan coil units listed to CAN/CSA C22.2 No. 236.
- .3 Fan coil performance certified to AHRI 440.
- .4 Fan coil arrangement:
 - .1 2- pipe heating & cooling
- .5 Hydronic coils to have Canadian Registration Number in accordance with CSA B51.
- .6 Manufacturers:

Standard of Acceptance

-
- Daikin
- Engineered Air
- Rosemex
- Carrier
- International Environmental
- McQuay
- York
- USA Coil & Air
- Trane
- Airtherm

2.2 Common Requirements

- .1 Coils:
 - .1 tubes:
 - (a) seamless copper tubing with evenly spaced aluminum fins mechanically bonded to tubing,
 - (b) Ø15mm (1/2 in. dia.) copper to ASTM B75, minimum 0.4mm (0.16 in) wall thickness, serpentine or header circuited,
 - .2 fins: aluminum, minimum 0.11 mm (0.0045 in.) thickness,
 - .3 fin density: not more than 640 fins/m (16 fins/in),
 - .4 coil rows: as shown,
 - .5 manual air vents,
 - .6 factory leak tested at 1.5 times design pressure with air when coil submerged in water.
 - .7 coil connections: brass unions.
- .2 Fans:
 - .1 statically and dynamically balanced, direct-drive, double width centrifugal fans with sleeve bearings,

- .2 fan scrolls and fan wheels: galvanized steel,
- .3 designed for easy removal and replacement.
- .3 Motors:
 - .1 variable-speed electrically commutated motor (ECM), permanently lubricated ball bearings, with built-in controller to accept a variable 0-10 V control input signal,
 - .2 internal thermal overload protection,
 - .3 motor connection: factor-wired harness with quick-connect electrical plugs,
 - .4 power supply: 208 V, single phase.
- .4 Drain pan:
 - .1 welded stainless steel drain pan, with extension under coil and internal piping and valve assemblies,
 - .2 drain pan externally lined with 12 mm (1/2 in.) thick closed-cell foam sheet insulation having a flame spread rating of not more than 25 and a smoke development rating of not more than 50 when tested in accordance with ULC-S102.2.
 - .3 NPS 3/4 copper tube main drain connected to bottom of drain pan, or side outlet with invert set 4 mm (1/4 in.) below bottom of drain pan,
 - .4 NPS 1/2 copper tube secondary high-level drain connection, set near the top edge of the drain pan wall.
- .5 Filters:
 - .1 disposable MERV 8 pleated panel aluminum framed, permanent, MERV 6 non-metallic washable panels.

2.3 Cabinet Units

- .1 Surface mounted, recessed, or semi-recessed, horizontal or vertical type as shown,
- .2 Cabinet unit casings:
 - .1 1.2 mm (18 ga.) galvanized steel with factory applied baked primer,
 - .2 internal insulation lining:
 - (a) 12 mm (1/2 in.) thick IAQ fiberglass 12 mm (1/2 in.) thick foil faced fiberglass 6 mm (1/4 in.) thick closed-cell sheet foam duct liner,
 - (b) with flame spread rating of not more than 25 and smoke development rating of not more than 50 when tested in accordance with ULC-S102.2.
 - .3 mechanically fastened removable access panels allowing service of fans, coils, isolating valves and controls.
 - .4 finish:
 - (a) factory prime and powder-coated finish paint coats,
 - (b) finish colour: brilliant white, cloud white, flat black, gray, beige, brown, as determined by Consultant.
- .3 Supply duct collars for connection at the coil frame.
- .4 Filters:
 - .1 filter mounting frame attached to cabinet, with access as shown,
 - .2 factory-supplied filters as specified herein.

2.4 Concealed Units

- .1 For installation concealed in concealed ceilings, furring or in enclosures supplied under other Divisions.
- .2 Fan plenums: 1.2 mm (18 ga.) galvanized steel fan enclosure, with bottom or rear inlet connection as shown.
- .3 Filters:
 - .1 filter mounting frame attached to fan plenum, with access as shown.
 - .2 factory-supplied filters as specified herein.
- .4 Supply duct collars for connection at the coil frame.

2.5 Motor Controller

- .1 Single-phase combination motor starter and disconnect switch, factory wired and mounted inside cabinet behind access door, on side of coil frame,
- .2 With factory-wired three-speed controller for PSC motors, wiring harness for variable 0-10 V input signal for ECM motors

2.6 Unit Operating Controls

- .1 Control valves and unit controller provided under Division 25.
- .2 Factory controls:
 - .1 control system with cabinet mounted thermostat, electric on/off automatic control valve, and aquastat clamped to water supply line to unit.
 - .2 control valves:
 - (a) automatic control valves selected for a pressure drop of 30 kPa (4.5 psi) at design flow rate,
 - (b) close-off differential pressure rating: 1000 kPa (150 psi)
 - (c) valve pressure rated: same as coil rating.
 - (d) characterized ball valve for equal-percentage control,
 - .3 valve actuator: electronic proportional control (floating point not permitted),
 - .4 control sequence, stand-alone operation:
 - (a) when water temperature is below aquastat setting, thermostat starts fan and opens cooling valve if room temperature rises above set point.

3 EXECUTION**3.1 Unit Supports**

- .1 Attach units to building structure with angles, hanger rods and supplementary suspension steel before installation of piping.
- .2 Provide spring isolation hangers for suspended units and flexible duct connections for suspended units with ducted supply or return.

3.2 Piping Installation

- .1 Make piping connections to fan coil units as follows:
 - .1 supply piping: provide manual shut-off ball valve, strainer, union, and flexible connector,

- .2 return piping: provide manual shut-off ball valve, pressure independent control valve, union and flexible connector,
 - .3 make connections to coils in accordance with manufacturer marked supply/return connections. In the absence of such markings, connect the supply pipe to the coil connection closest to the coil discharge face,
 - .4 provide unions between the flexible connector and pipeline, unless flexible connector is provided with an integral union joint.
- .2 Flexible connector installation:
- .1 locate flexible connectors between the coil connections and valves and strainers,
 - .2 arrange flexible connectors to remain in a single plane, with the maximum offset in any direction not exceeding 25 mm (1 in.).
 - .3 do not bend flexible connectors; provide an elbow fitting on coil connection.
- .3 Provide coil drain on supply side piping.
- .4 Provide screwdriver air vents on both supply and return piping between valves and flexible connectors.

3.3 Package Controls

- .1 Install interconnecting wiring between thermostats, multi-speed controllers, motor starter switches and other controls.

3.4 Cabinets and Enclosures

- .1 Install cabinets tight against furrings, columns, or wall surfaces.
- .2 Enclosure lengths to be job measured at site where enclosure extends between walls, furrings or similar fixed objects.
- .3 Provide elements, hangers, hanger brackets and piping connections where enclosures are provided under another Division.

3.5 Completion

- .1 Clean coils and comb fins on finned elements.
- .2 Set isolating valves open and adjust supply grilles.
- .3 Re-finish units damaged during installation.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

RADIANT CEILING PANELS

23 83 16

1 GENERAL

1.1 Scope

- .1 Install radiant ceiling panels as shown.
- .2 All panels are to be vandal resistant, anti ligature with security mounting.
- .3 Size of all panels to be 900mm (36") wide, 12 row

1.2 Submittals

- .1 Submit shop drawings drawn to scale showing:
 - .1 panel layouts,
 - .2 interconnections between panels,
 - .3 hanging details,
 - .4 piping connection details,
 - .5 ceiling plan coordination.

2 PRODUCTS

2.1 Standard of acceptance

- .1 Panels to be manufactured by company regularly engaged in field with cataloged performance information and certified test data.

Standard of Acceptance

- Airtex - Engineered Air
- Frenger
- Sigma
- Rosemex
- Sun El

2.2 Ratings

- .1 Selection of radiant panels to meet capacities shown on drawing to be based on:
 - .1 Entering water temperature: 76.7°C (170°F)
 - .2 Water temperature drop: 11°C (20°F)
 - .3 Ambient air temperature: 19.5°C (67°F) and natural convection.
- .2 design pressure: 1000 kPa (150 psi)

2.3 Linear Ceiling Panels

- .1 Construction:
 - .1 aluminum extrusions with 13 mm (½ in) copper tubing mechanically attached and thermally connected with heat conductive paste,
 - .2 paint finish selected from manufacturer's standard range.
- .2 Edge mouldings:

- .1 aluminum extrusions for exposed linear panels as shown.

.3 Drywall frame:

- .1 aluminum sections with welded corners, with finishing flange suitable for drywall installation,
- .2 fall arrest chains,
- .3 concealed cam-lock fasteners to lock panel into frame, with Torx head with centre pin reject socket.

2.4 Accessories

.1 Ceiling support:

- .1 By general trades Division of the work. Cross tees, main tees, and wall mouldings to match existing ceiling system.

3 EXECUTION

3.1 Co-ordination

- .1 Co-operate with other trades working within ceiling space and locate piping panels and hangers clear of other work.

3.2 Connections

- .1 Make interconnecting piping between panels with 360° interconnecting loops and 180° return bends of 13 mm (½ in) soft copper tubing.
- .2 Circuit panels as shown over length of zone.
- .3 Inlet water flow to enter panel adjacent cold surface.

3.3 Panel Layout and Supports

- .1 Install hanger wires at 1.2 m (4 ft) intervals
- .2 Fasten cross tees to wall mouldings and main tees, and tee to be flush on exposed side with moulding.
- .3 Cut holes in panels and divert piping to allow for sprinkler heads, pot lights, columns, and other features.

3.4 Panel Installation

- .1 Wear clean white gloves while installing panels.
- .2 Install heating panels after building is closed in and before installation of ceiling tile.
- .3 Insulate ceiling side of panel with 50 mm (2") fibreglass bat insulation. Extend insulation 100 mm (4") beyond edges of panel.
- .4 Connect piping with swing joints to allow for pipe expansion and contraction.
- .5 Install isolating valve on supply and double regulating valve on return of each panel zone.
- .6 Install modulating control valve on return from radiant panels as shown.

3.5 Installation - Linear Panels

- .1 Extend panels to walls or structure with inactive panel sections or inactive panel area.
- .2 Minimum panel widths to be as shown on drawings.

- .3 Panel dimensions to be field measured.
- .4 Mitre panels at corners.

3.6 Installation - Modular Panels

- .1 Confirm exact dimensions of T-bar openings and profile of ceiling system.
- .2 Restrain panel independent of ceiling grid system.
- .3 Drywall ceilings as shown on drawings.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

BUILDING AUTOMATION COMMON WORK RESULTS

25 05 01

1 GENERAL

1.1 Scope

- .1 Provide a building automation system ("BAS") for control and supervisory management of facility mechanical and electrical equipment systems.
- .2 The BAS is to be a direct digital control ("DDC") system with digital/electric instrumentation and electric operation, along with pneumatic operators for select control devices.

1.2 Dependent Sections

- .1 The BAS Work is further defined in the following specification sections:

25 05 02	Building Automation Alternate and Separate Prices
25 05 06	Work on Existing Building Automation
25 05 12	Building Automation Control Panels and Wiring
25 30 13	Building Automation Actuators and Operators
25 30 16.13	Building Automation Instrumentation
25 30 16.26	Building Automation Revenue Meters
25 30 19.13	Building Automation Control Valves
25 30 23.13	Building Automation Control Dampers
25 90 01	Building Automation Control Sequences

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the BAS system is further described in the following the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 12	Common Electrical Requirements for Mechanical Services
.2 20 05 49	Seismic Restraint
.3 20 08 11	Testing of Mechanical Life Safety and Fire Protection Requirements

1.4 Equipment Supplied for Installation under Other Sections

- .1 Supply the following equipment for installation under other Sections of Division 20;
 - .1 automatic control valves and pressure independent control valves,
 - .2 instrumentation including pressure sensors, flow meters and energy meters to be installed in piping systems,
 - .3 temperature wells for controllers and sensors provided under this Section, for installation in piping systems,
 - .4 instrumentation including air flow stations to be installed in ductwork systems,
 - .5 motorized dampers, except:
 - (a) where provided as part of factory built air handling units,
 - (b) motorized fire dampers, smoke dampers and/or combination fire/smoke dampers,

1.5 Factory Installation of Controls for Terminal Units

- .1 Supply control equipment for terminal units (as specified in section 23 36 13) free-issue to the place of the manufacturer of the terminal unit equipment, for factory installation of the control equipment by that manufacturer, including factory wiring and tubing installation. Such control equipment includes:
 - .1 TU-ASC controller,
- .2 Provide information on sizing requirements for electrical transformer or power supply, sized for all control loads including controller, damper actuator, and for control of any associated heating valves.
- .3 Coordinate with terminal unit manufacturer for delivery of controls material to suit their production schedule.
- .4 All costs associated with such method of factory installation is to be borne by the mechanical subcontractor and controls subcontractor as determined between them; the Owner shall not be responsible for any such costs.

1.6 Equipment Provided under Other Divisions

- .1 The following equipment is provided under other Sections of Division 20;
 - .1 steam humidifiers with automatic control valves,
 - .2 unit heater and cabinet unit heater line voltage thermostats,
 - .3 manual dampers, non-motorized fire dampers, and gravity dampers,
 - .4 motorized fire dampers, smoke dampers and combination smoke/fire dampers, including damper actuators,

1.7 Definitions and Abbreviations

- .1 The following definitions, abbreviations, and acronyms apply to this Division of the Work:
 - .1 AI Analog Input: continuously variable value, usually a sensor, referenced to a controller
 - .2 AO Analog Output: continuously variable value, usually a control signal to an actuator device, referenced to a controller.
 - .3 ASC Application Specific Controller
 - .4 DI Digital Input: a two-state (On-Off) value, usually associated with a switch or state, referenced to a controller.
 - .5 DO Digital Output: a two-state (On-Off) value, usually associated with starting or stopping equipment or generating an alarm, referenced to a controller.
 - .6 FC Fail Close (valve or damper action on failure of the controller)
 - .7 FO Fail Open (valve or damper action on failure of the controller)
 - .8 FAS Fire Alarm System
 - .9 GUI Graphic User Interface: an LED, LCD or monitor display
 - .10 I/O Input/Output
 - .11 LAN Local Area Network
 - .12 NC Normally Closed: position of device in a de-energized state.
 - .13 NO Normally Open: position of device in a de-energized state.
 - .14 NSC Network Supervisory Controller
 - .15 OEM Original Equipment Manufacturer

- .16 OWS Operator workstation: a PC based server or computer
- .17 Tier 1 Building level network providing communication between NSCs and workstations.
- .18 Tier 2 Field level network providing communications between ASCs and NSCs
- .19 WAN Wide Area Network

1.8 Applicable Codes and Standards

- .1 Product standards:
 - .1 ANSI/ASHRAE 135 BACnet – A Data Communication Protocol for Building Automation and Control Networks
 - .2 ANSI/CEA 709.1 Control Network Protocol Specification (Lonworks)
- .2 Interfacing Standard:
 - .1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EI (Electronic Industry Association) interfaces.
 - (a) CSA T530 Commercial Building Standard for Telecommunications Pathways and Spaces
 - (b) IEEE 802.3 Ethernet

1.9 Qualified Tradesperson

- .1 Work to be performed by a qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.
- .2 BAS to be provided by an organization that:
 - .1 specializes in design, installation, commissioning, and service of BAS systems,
 - .2 has completed five (5) projects of similar size and complexity within the preceding five (5) years,
 - .3 employs licensed journeymen experienced in this type of work,
 - .4 is either:
 - (a) a controls manufacturing company listed under the following Standard of Acceptance to directly perform the Work, or
 - (b) provided by an authorized controls distributor-contractor of the listed manufacturer, to perform the Work.

Standard of Acceptance

- **Carrier**

1.10 Design Services

- .1 Provide engineering services for the design of the BAS including product selection, wiring details, and all installation details to meet the prescribed and performance requirements described in the specifications sections of Division 25. Issued design documents are to be sealed by a professional engineer licensed in the province of the Work.
- .2 Prior to preparation of shop drawings for the BAS, provide a design assist to review Consultant's sequence of operation and provide feedback on any recommendation that may improve the installation or ease of operation, while remaining within the hardware scope as originally designed and specified herein.

1.11 Licences and Ownership

- .1 Ownership of, and licences for, hardware and software supplied or used for this project or for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.
- .2 This is applicable to System Software, Workstation Application Editors, and Controller Software.
- .3 Licensing to permit an unlimited number of users to access system without additional fees.
- .4 At the time of substantial performance of the Work, upgrade the BAS software to the most current release version at that time, at no additional cost to the Owner.
- .5 Project-developed software and resulting documentation to be treated as part of system and subject to these same requirements for ownership and licensing. This material includes;
 - .1 project graphic images,
 - .2 CAD generated record drawings,
 - .3 project database,
 - .4 project-specific application programming code and documentation.

1.12 Seismic Qualification

- .1 Seismically qualify (certify) control panels for the BAS to remain operational after being subjected to the design seismic forces assuming a building height factor (NBCC) $A_x = 3.0$ with equipment rigidly mounted, by the shaker table method in accordance with Specification section 20 05 49.

1.13 Submittals

- .1 Submit one (1) completely engineered and coordinated shop drawing package. Partial or incomplete submission of data and/or drawings will be returned without review.
- .2 Submit shop drawings for designed elements;
 - .1 list of materials of equipment to be used indicating manufacturer, model number, and other relevant technical data,
 - .2 BAS riser diagram showing system controllers, operator workstations, network devices, and network wiring,
 - .3 control panel internal wiring diagrams, .
 - .4 single-line schematics and system flow diagrams showing location of control devices,
 - .5 wiring diagrams identifying interface hard-wire terminations to controlled equipment OEM control panels,
 - .6 points list for each system controller, including: Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Panel, Reference Drawing, and Cable Number,
 - (a) points to be named by function, and list to include software points such as programmable set-points, range limits, time delays, and so forth,
 - .7 detailed analysis of each Sequence of Operation from Consultant's design documents, ready for development of actual programming code,
 - .8 written Sequence of Operations to cover normal operation and operation under various alarm conditions applicable to that system.
- .3 Submit shop drawing schedules for;
 - .1 control dampers: spreadsheet type, to include separate line for each damper and columns for damper attributes.

- .2 control valve: spreadsheet type, to include separate line for each valve and separate columns for valve attributes.
- .4 Submit catalogue cut-sheets for:
 - .1 manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for equipment and hardware items as follows;
 - (a) controllers (NSC's and ASC's),
 - (b) instrumentation, including
 - i) accuracy data, range and scale information,
 - ii) one sheet for each device marked with applicable options. Where several devices of same type are to be used, submit one sheet for each device, individually marked.
 - (c) actuators,
 - (d) valves and dampers,
 - (e) relays/switches,
 - (f) control panel enclosures,
 - (g) power supplies,
 - (h) batteries,
 - (i) GUI operator interfaces,
 - (j) wiring and wiring accessories.
- .5 Submit supporting documentation:
 - .1 representative examples of graphics for GUI to include;
 - (a) BAS network schematics,
 - (b) typical terminal unit floor plan graphic that shows conditions on occupied floor,
 - (c) typical equipment room floor plan graphic,
 - (d) typical graphics for each system and terminal unit at least one sample graphic for each type of equipment,
 - (e) one sample graphic for chilled water system,
 - (f) one sample graphic for hot water system,
 - (g) description of techniques used for dynamic display of information on graphics and method of how building operator drills down to secondary information and affects control of equipment.
 - .2 Protocol Implementation Conformance (PIC) statement for BACnet devices,
 - .3 where interfaces occur with control or wiring diagrams of other sections, obtain reproducible copies of those diagrams and revise to show terminal numbers at interface and include diagrams as part of interconnection schematic shop drawings.

1.14 Project Schedules

- .1 At time of shop drawing submission provide a Gantt type schedule of Work with;
 - .1 project broken down into discrete work elements by system,
 - .2 start date of each work element,
 - .3 duration of each work element,
 - .4 relationships between work elements and showing constraints on work flow,
 - .5 planned delivery dates for ordered material and equipment with expected lead times,
 - .6 procedures.

- .2 During design, installation and start-up of installation provide monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated Schedule of Work with each report.

1.15 Quality Control

- .1 Continuity of staff and subcontractors:
 - .1 Controls contractor's project manager is to be nominated at time of shop drawing submission and is to remain involved with the project, from shop drawing preparation through to project acceptance, unless a request for change of personnel is submitted to and approved by Owner.
 - .2 Subcontractors listed in preliminary design submission are to execute the Work defined as sublet in preliminary design document unless request for change is submitted to and approved by Owner.
 - .3 Requests for changes in staff, subcontractors, or extent of work subcontracted are to be submitted for approval by Owner and such approval is not to be unreasonably withheld.
- .2 Identification of non-conforming materials and equipment:
 - .1 Submit documentation at time of bid, identifying nature and extent of non-conformance and variances from specifications or referenced standards.
 - .2 Failure to submit this documentation at time of bid will be interpreted as confirmation that materials, workmanship, hardware, and software will be in strict accordance with specifications and standards.
- .3 All products that are connected to a piping system that is subject to registration under applicable boiler and pressure vessel legislation are to have current Canadian Registration Numbers in accordance with CSA B51.

1.16 Warranty

- .1 At completion of Work, submit written guarantee undertaking to remedy defects in work for period of two (2) years from date of acceptance, which includes:
 - .1 rectification of control system failures attributable to defects in workmanship, materials, hardware, and software,
 - .2 service technician to arrive on site within 24 hours of warranty service request, to install and debug software patches, to replace defective parts, materials or equipment, and to provide incidental supplies, and labour for remedial work,
 - .3 technician to remain in attendance until system is returned to operating condition.
- .2 Submit similar guarantee for any part of the Work accepted by Owner, before completion of whole work.

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges unless otherwise specified in other specification sections of Division 25:
 - .1 temperature: 0°C to 40°C (32°F to 104°F)
 - .2 relative humidity 10% to 90% non-condensing
 - .3 electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.
- .2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

2.2 Equipment Standard

- .1 Products and software: manufacturer/developer/supplier's catalogued current stock.
- .2 This installation is not to be used as test site for newly developed product or software, without explicit written approval by Owner.
- .3 Equipment and systems installed to meet;
 - .1 performance specifications when subjected to VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes,
 - .2 Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices.

2.3 BAS General Functional Requirements

- .1 Control mechanical and electrical equipment as specified in control sequences, shown on control schematics, detailed in Points Lists, and described in equipment schedules.
- .2 Scalable system architecture to be modular, permitting stepped expansion of application software, system peripherals, and field hardware.
- .3 Control system:
 - .1 high-speed, peer-to-peer network of microprocessor based Direct Digital Control (DDC) controllers with web-based operator interface,
 - .2 each mechanical system, building floor plan, and control device to be displayed through point-and-click graphics,
 - .3 Web server with network interface card to gather data from this system and generate web pages that can be accessed through conventional web browser on any PC connected to network,
 - .4 operators to access this system through web browser on connected PC's, wireless tablet PCs and smart phones to perform normal operator functions,
 - .5 scalable, modular, automatic process and optimized workflows, with automatic data acquisition and energy performance analytics,
- .4 Each controller;
 - .1 operates with local closed loop programming, independent from server, able to continue functional control if peer-to-peer communication is interrupted;
 - .2 performs resident control routines;
 - (a) receiving information from field mounted sensors and switches and
 - (b) transmitting instructions to actuators to perform control sequences.
 - .3 manages local hardware and software alarms;
 - (a) to collect historical data,
 - (b) to facilitate operator input and output,
 - (c) to communicate with Central BAS web server and GUI.
- .5 Central BAS Web server;
 - .1 performs global application programs and data consolidation;
 - (a) communicating with controllers,
 - (b) obtaining data from field devices for central monitoring of building systems, and
 - (c) transmitting instructions to controllers.
 - .2 has software routines for;
 - (a) BAS Server operation,

- (b) database creation and data storage,
- (c) web based GUI with graphics generation and display,
- (d) report formulation, printing, and presentation,
- (e) alarm detection, management and reporting,
- (f) event initiated programming.

2.4 Network Integration Functional Requirements

.1 Open protocol:

- .1 Provide an integrated, open protocol building automation system using BACnet to ANSI/ASHRAE Standard 135, with native integration with:
 - (a) Lonworks,
 - (b) Modbus,
 - (c) OPC (OLE for process control).
 - (d) ONVIF,
 - (e) DALI.

.2 Integral systems integration functionality:

- .1 provide hardware and software to allow bi-directional digital communications between BAS and facility control subsystems including:
 - (a) HVAC,
 - (b) fire safety including fire alarm systems,
 - (c) security systems,
 - (d) power control and monitoring systems,
 - (e) lighting control systems,
 - (f) 3rd party integration with other facility systems.

.3 OEM Controller integration:

- .1 provide hardware and software to allow bi-directional digital communications between BAS and 3rd party manufacturers' equipment control panels including but not limited to;
 - (a) boilers,
 - (b) chillers,
 - (c) variable frequency drives,
 - (d) packaged HVAC equipment,
 - (e) power monitoring equipment,
 - (f) medical gas equipment.
- .2 integrate real-time data from these systems.

2.5 BMS Network Architecture

- .1 Refer to specification section 25 05 06 for work required on existing BAS networks.

2.6 Performance

.1 General:

- .1 information transmission and display times are based upon network connections,

- .2 test systems using manufacturer's recommended hardware and software for operator interface.
- .2 Performance criteria:
 - .1 Graphic Display;
 - (a) display graphic with 50 dynamic points with current data within 10 seconds.
 - .2 Graphic Refresh;
 - (a) update graphic with 50 dynamic points with current data within 10 seconds and
 - (b) automatically refresh every 15 seconds.
 - .3 Configuration and Tuning Screens;
 - (a) special screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic to refresh every 5 seconds.
 - .4 Object Command response;
 - (a) time between command of binary object at GUI and onset of reaction by device to be less than 5 seconds,
 - (b) time between command of analog object at GUI and start of adjustment to be less than 5 seconds.
 - .5 Alarm Response Time;
 - (a) time between when an object goes into alarm and when it is annunciated at GUI to be less than 15 seconds.
 - .6 Program Execution Frequency;
 - (a) execution repeat frequency to be selected in manner consistent with process under control,
 - (b) custom and standard applications to be capable of executing as often as once every 5 seconds.
 - (c) programmable controllers to be able to perform PID control loop routines at selectable frequency, adjustable at GUI down to once every second.
 - (d) workstations connected to network to receive alarms with not more than 5 seconds spread between first and last annunciation.

2.7 Capacity for Future Expansion

- .1 Tier 1 network;
 - .1 network backbone to have capacity for future 50 routers or building controller/routers in addition to connected devices at time of acceptance of the Work,
 - .2 each router or building controller/router on network backbone to have routing capacity for 50 controllers.

2.8 Wiring and Conduit

- .1 Wire and conduit for power wiring, control wiring, and communication wiring to conform to specification section 20 05 12.

3 EXECUTION

3.1 Examination

- .1 Inspect site and thoroughly examine documents to establish locations for control devices and equipment and report discrepancies, conflicts, or omissions for resolution before starting rough-in work.
- .2 Be responsible for correction of defects caused through neglect of inspections and examinations or failure to report and resolve discrepancies.

3.2 Protection

- .1 Protect work and material against damage during construction and be responsible for work and equipment until inspected, tested, and accepted.
- .2 Protect material not immediately installed and seal connector terminations with temporary covers or plugs during storage and construction to prevent entry of foreign objects.
- .3 Protect electronic equipment from elements during construction.

3.3 Coordination

- .1 Coordinate and schedule BAS work with other work in same area to ensure orderly progress.
- .2 Testing and balancing:
 - .1 Supply sets of tools of sufficient quantity for Testing and Balancing Technicians to interface to control system, train these technicians in use of tools, and provide qualified Control Technician to assist with testing and balancing the first 10 terminal units.
 - .2 Tools to be turned over to Owners on completion of testing and balancing.
- .3 Controls work by others:
 - .1 Integrate and coordinate this control work with controls and control devices provided or installed by others.
 - .2 Each supplier of control product to configure, program, start up, and test that product to satisfy requirements of Sequence of Operation regardless of where within contract documents product is specified or described.
 - .3 Resolve compatibility issues between control products provided under this Division and those provided under other Divisions of the Work.

3.4 General Workmanship

- .1 Installation to be performed by skilled and certified technicians.
- .2 Install equipment, piping, and wiring or raceways horizontally, vertically, and parallel to building lines.
- .3 Provide sufficient slack and flexibility in connections to allow for vibration isolation between conduit, raceways, piping and equipment.
- .4 Install instrumentation and devices in locations providing adequate ambient conditions.
- .5 Protect components placed in areas of potentially high humidity.

3.5 Wiring for Power, Control and Communications

- .1 Provide wire and raceways (conduit) for power wiring, control wiring, and communications wiring for BAS controllers and associated instrumentation and actuation devices, at voltages of 120 V and under, in accordance with specification section 20 05 12 and, for greater clarity, Schedule A appended to that specification section.
- .2 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

3.6 Cleaning

- .1 Clean up debris, remove packaging material, collect waste and place in designated location, on a daily basis.
- .2 Keep work areas free from dust, dirt, and debris.

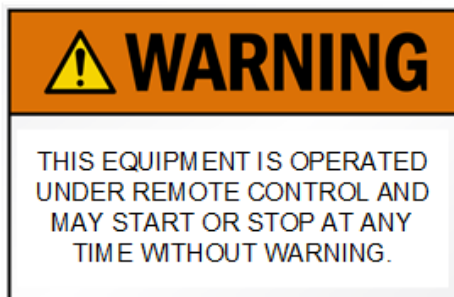
- .3 On completion of work, check finish of equipment provided under this section for damage and repair damaged factory-finished paint, replace deformed cabinets and enclosures with new material, and repaint to match original.
- .4 Prior to hand-over to the Owner, clean the inside of control panels;
 - .1 remove debris and vacuum clean internal components,
 - .2 the use of low-pressure dry nitrogen or inert compressed gases may be used to blow dust and debris out of panels where the use of such pressurized gases will not damage equipment or loosen wiring terminations,
 - .3 after cleaning, apply a label to the exterior side of the panel to identify the date the panel was cleaned and the initial of the person who cleaned the panel.

3.7 Field Quality Control

- .1 Ensure work, materials, and equipment comply with this specification and reviewed shop drawings.
- .2 Monitor field installation for applicable safety and building code compliance and workmanship quality.
- .3 Arrange and pay for inspections by local or provincial authorities having jurisdiction over the work.

3.8 Identification of Equipment

- .1 Manufacturers' nameplates and product certification labels to be visible and legible after equipment is installed.
- .2 Identify discrete items of equipment with plastic nameplates or plasticized labels, identifying equipment and function. Identification plates are in addition to manufacturers nameplates.
- .3 Identification plates:
 - .1 provided for equipment identified with number designations in schedules and equipment shop drawings.
 - .2 marked with equipment type, number and service following wording and numbering used in contract documents and shop drawings,
 - .3 plastic laminated labels,
 - .4 white face and black background field,
 - .5 minimum size 75 mm x 40 mm x 3 mm (3 in x 1½ in x 1/8 in),
 - .6 engraved or printed with 6.5 mm (1/4 in) high lettering.
 - .7 securely attached to equipment with brass chains.
- .4 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 50 mm (2 in) of termination.
- .5 Label pneumatic tubing at each end within 50 mm (2 in) of termination with descriptive identifier.
- .6 Permanently label or code each point of field terminal strips to show instrument or item served.
- .7 Label each control component with permanent label. Label plug-in components so that label remains stationary during component replacement.
- .8 Label room sensors related to terminal boxes or valves with nameplates. Place labels on back of sensors.
- .9 Identify motor controllers that are remotely controlled by the BAS with self-adhesive labels, black letters on white background with a red border and electric shock warning icon, with wording as follows;



3.9 Checkout and Testing

- .1 Provide schedule for start-up and testing.
- .2 Calibrate and prepare for service equipment, instruments, controls, and accessories.
- .3 Start-up testing to verify completion of control system before system demonstrations begin;
 - .1 verify that control wiring is connected and free of shorts and ground faults. Verify that terminations are tight,
 - .2 enable control systems and verify input device calibration,
 - .3 verify that binary output devices operate and that normal positions are correct,
 - .4 verify failure positions of dampers and control valves are correct when power/compressed air is deenergized to the device,
 - .5 verify that analog output devices are functional, that start and span are correct, and that direction and normal positions are correct,
 - .6 check control valves and automatic dampers for proper action and closure and adjust valve stroke/rotation and damper blade travel,
 - .7 verify that damper and control valve feedback signals are correct when device is stroked fully open and closed (two position) and at any opening position between zero and fully open (modulating devices),
 - .8 verify that system operates according to Sequences of Operation. Simulate changes in variables by overriding and varying inputs and schedules and observe and record each operational mode response.,
 - .9 tune PID loops and control routines to provide stabile operation and to minimize valve and damper hunting,
 - .10 check each alarm with an appropriate signal at value that will trip alarm,
 - .11 trip interlocks using field contacts to check logic and to ensure that actuators fail in proper direction,
 - .12 test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.
- .4 Prepare and submit test log documenting start-up testing of each input and output device and each control routine, with technician's initials certifying each device and each routine is functioning correctly and sensors have been calibrated. Include list of deficiencies and a workplan schedule setting out rectification program with time lines.

3.10 Testing of Integrated Life Safety and Fire Protection Systems

- .1 Comply with the requirements of specification section 20 08 11 for the testing of the integration of controls and communications between the BAS and life safety and fire protection systems.

3.11 Control System Demonstration

- .1 Obtain approval of start-up testing log and rectification program before scheduling demonstrations.
- .2 Provide notification to Owner and Consultant not less than 10 business days before system demonstration begins.
- .3 Demonstration to follow previously submitted and approved procedures;
 - .1 submit checklists and report forms for each system as part of demonstration,
 - .2 lists and forms to have initials of technicians conducting demonstrations,
 - .3 date of each demonstration and signatures of Owner's representatives witnessing each demonstration section.
- .4 Prior to acceptance, perform the following operating tests in the presence of the Owner or Owner's representative and Consultant to demonstrate system operation and compliance with specification after and in addition to tests specified above in article Checkout and Testing.
- .5 Demonstrate field operation of;
 - .1 each Sequence of Operation,
 - .2 Operator Interface,
 - .3 control loop response with graphical trend data output showing;
 - (a) each control loop response to set point change producing an actuator position change of at least 25% of full range.
 - (b) trend sampling rate to be from 10 seconds to 3 minutes, depending on loop speed,
 - (c) loop trend data to show set point, actuator position, and controlled variable values,
 - (d) documentation of further tuning of any loop that displays significantly under- or over-damped control
 - .4 demand limiting routine with trend data output showing demand-limiting algorithm action;
 - (a) trend data to document action sampled each minute over at least 30-minute period and to show building kW, demand-limiting set point, and status of set-points and other affected equipment parameters.
 - .5 control integration with life safety and fire protection systems,
 - .6 trend logs for system points as selected by the Owner with;
 - (a) trend data to indicate set-points, operating points, valve positions, and other data as specified in points list provided with each Sequence of Operation,
 - (b) each log to cover three 48-hour periods and to have sample frequency not less than 10 minutes, except where a Control Sequence specifies other time intervals,
 - (c) show that trend logs are accessible through operator interface and can be retrieved for use in other software programs.
 - .7 substantiate calibration and response of any input and output points requested,
 - .8 provide at least two technicians equipped with two-way communication,
 - .9 provide and operate test equipment to establish calibration and prove system operation.
- .6 Tests that fail to demonstrate system operation are to be repeated after repairs and/or revisions to hardware or software is completed.

3.12 Training

- .1 Materials:
 - .1 provide course outline and materials for each class at least four (4) weeks before first class,

- .2 provide training through instructor-led sessions, with computer-based, or web-based techniques,
- .3 instructors to be factory-trained and experienced in presenting this material,
- .4 perform classroom training using network of working controllers representative of installed hardware.
- .2 Operating staff training:
 - .1 provide training for Owners operating staff using abovementioned training materials in self-paced mode, web-based or computer-based mode, classroom mode, or combination of these methods,
 - .2 allow for 1 repeat sessions for each category to cover operator shift rotation.
- .3 Training to enable students to accomplish following objectives:
 - .1 Group 1:
 - (a) proficiently operate system,
 - (b) understand control system architecture and configuration,
 - (c) understand BAS system components,
 - (d) understand system operation, including BAS system control and optimizing routines (algorithms),
 - (e) understand Sequence of Operations,
 - (f) operate workstation and peripherals,
 - (g) log on and off system,
 - (h) access graphics, point reports, and logs,
 - (i) adjust and change system set-points, time schedules, and holiday schedules,
 - (j) recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools,
 - (k) understand system drawings and Operation and Maintenance manual,
 - (l) understand project layout and location of control components,
 - (m) access data from BAS controllers,
 - (n) set-up trend logs,
 - (o) operate portable operator's terminals
 - .2 Group 2:
 - (a) create and change system graphics,
 - (b) create, delete, and modify alarms, including configuring alarm reactions,
 - (c) create, delete, and modify point trend logs (graphs) and multi-point trend graphs,
 - (d) configure and run reports,
 - (e) add, remove, and modify system's physical points,
 - (f) create, modify, and delete application programming,
 - (g) add and configure GUIs,
 - (h) add new controller to system,
 - (i) download firmware and advanced applications programming to controller,
 - (j) configure and calibrate I/O points.
 - .3 Group 3:
 - (a) maintain software and prepare backups,
 - (b) interface with job-specific, third-party operator software,

(c) add new users and understand password security procedures.

.4 Divide presentation of objectives into three sessions:

- .1 Group 1: Day-to-day Operators,
- .2 Group 2: Advanced Operators,
- .3 Group 3: System Managers and Administrator,
- .4 participants will attend one or more sessions, depending on knowledge and expertise level required,
- .5 provide each student with one copy of training material.

3.13 Record Submittals

.1 Submit record documents to the Owner.

.2 Document language: English

.3 Submit three copies of project record documents and obtain approval during acceptance procedures.

.4 Submit AHJ inspection certificates.

.5 Provide as-built drawings;

- .1 as-built interconnection wiring diagrams, or wire lists of field installed system with identified, ordering number of each system component and service,
- .2 floor plans with accurate depiction of location of system devices, controllers, and trunk wiring. Drawings to be constructed using Architectural backgrounds provided,
- .3 provide copies of as-built drawings on two (2) removable storage devices,
- .4 provide five (5) full size hard copies of floor plan drawings.

.6 Operation and Maintenance (O&M) Manuals:

- .1 provide two (2) paper copies of material and copies on five (5) removable storage devices in portable document format.
- .2 describe operation, maintenance and servicing requirements of system and associated equipment,
- .3 provide the following information in separate sections, each with an index:

(a) Service and parts;

- i) names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems,
- ii) list of recommended spare parts with part numbers and suppliers.

(b) System description;

- i) outline of BAS system and system architecture,
- ii) as-built versions of shop drawing product data,
- iii) reduced size (11 in x 17 in) copies of record drawings,
- iv) graphic files, programs, and database on magnetic or optical media,
- v) licenses, guarantees, and warranty documents for equipment and systems.

(c) Technical literature for equipment, including;

- i) catalogue sheets,
- ii) calibration, adjustments and operation instructions,
- iii) installation instructions,

- iv) hardware and software manuals, with information supplied by original product developer, on application programs and on computers and controllers supplied,
- v) Operator's manual with procedures for operating control systems; logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set-points and variables,
- vi) engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware,
- vii) original-issue documentation with installation and maintenance information for third-party hardware including computer equipment and sensors,
- viii) recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions,
- ix) programming manual or set of manuals with description of programming language and syntax, explanation of statements for algorithms and calculations used, procedures for point database creation and modification, documentation of techniques for program creation and modification, and instructions for use of editor,
- x) documentation of programs created using custom programming language including set-points, tuning parameters, and object database. Electronic copies of programs to modify and create control logic, set-points, tuning parameters, and objects that can be viewed using programming tools.

.7 Original Software:

- .1 Furnish one original set of application and system software on original media. Disks to bear manufacturer's label. Field copies are not acceptable.
- .2 Original-issue copies of software to include operating systems, custom programming language, application generation, graphic support, maintenance support, operator workstation or web server software, and other utilities provided in support of installed system.

.8 On-line record documentation:

- .1 After completion of testing and adjustment, install the following additional information on the server OWS.
 - (a) as-built record drawing files,
 - (b) detailed catalog data on all installed system components, with supplier contact information for purchasing and factory authorized repair service.

3.14 Acceptance

- .1 Application for substantial performance of the Work requires as a prerequisite the completion of the BAS including testing, demonstration, and submittal of required documentation, except where the Owner agrees to differ any work to a later date.
- .2 In support of an application for substantial performance, submit a signed declaration to the Owner certifying that:
 - .1 the BAS is complete and operating in accordance with the contract documents,
 - .2 control system checkout and testing is completed,
 - .3 control system demonstration is completed,
 - .4 training is completed,
 - .5 as-built documentation is completed and turned-over to the owner.

- .3 Certification document may identify tests that cannot be performed due to extenuating circumstances such as weather conditions, where previously agreed to be deferred to a later date by the Owner. Append a program for completion of deferred work to the certification document for rectification and completing these tests during warranty period.

3.15 Correction After Completion

- .1 After start-up, testing, and commissioning phase has been completed and satisfactory and reliable operation of equipment and systems has been demonstrated, acceptance of the system is to be given by Owner. Warranty period to begin on date established on certificate of acceptance.
- .2 Provide updates and patches to resolve software deficiencies in operator workstation or web server software, project-specific software, graphic software, database software, and firmware during warranty period.
- .3 Provide upgrades that improve routines and procedures of operator workstation software, web server software, project-specific software, graphic software, or database software, free of charge, during warranty period.
- .4 Provide details of proposed changes and obtain written authorization from Owner before installation of updates, patches, or upgrades.
- .5 Include preventative maintenance, with allowance for spare parts, labour, and emergency (24 hour) service for system and equipment during warranty period.
- .6 Equipment manufacturers to submit written undertakings to make circuit board repairs and provide spare parts, software support and patches, and technical assistance for at least five years after acceptance is certified.

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

WORK ON EXISTING BUILDING AUTOMATION

25 05 06

1 GENERAL

1.1 Scope

- .1 Modifications to existing building control systems including:
 - .1 connection to of new BAS networks to the existing building BAS networks,
 - .2 connection of new control devices to existing BAS networks,
 - .3 modifications and upgrades of existing BAS.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 25 05 01 Building Automation Common Work Results

1.3 Definitions and Abbreviations

- .1 Refer to specification section 25 05 01.

1.4 Designated Controls Contractor

- .1 BAS work shall be performed by the base building controls contractor authorized by the Owner to perform such Work.

1.5 Design Criteria

- .1 Existing BAS networks:
 - .1 Tier 1: dedicated BACnet /IP, BACnet /Ethernet, control vendor proprietary.
 - .2 Tier 1: hosted on facility IT network.
 - .3 Tier 2: BACnet MSTP, control vendor proprietary.

1.6 Submittals

- .1 Shop drawings:
 - .1 In addition to the requirements of section 25 05 01, submit the following information as a shop drawing:
 - (a) documentation of existing sequence of operations for applicable equipment and systems affected by the Work.

2 PRODUCTS

2.1 General

- .1 Conform to specification section 25 05 01 and other sections of Division 01 except as specified herein.

2.2 Application Specific Controller Upgrades

- .1 Replace the following ASC devices with new products in accordance with specification section 25 05 01 and reference specification sections.

- .1 replace all ASCs controlling existing equipment in the project work zone for the following equipment types:
 - (a) terminal units (VAV boxes),
 - (b) unit heaters,
 - (c) fan coil units,

2.3 Data and Graphic Upgrades

- .1 Upgrade existing data presentation and graphic displays on existing-to-remain NSC and ASC devices, by providing a new Web server with GUI graphics to comply with the requirements for new products in accordance with specification section 25 05 01 and reference specification sections.
- .2 Develop new graphics to display existing data tables and/or graphical display of control systems, along with additional features as shown.

3 EXECUTION

3.1 Existing Equipment

- .1 Reuse of control components:
 - .1 reuse existing equipment and components as listed below where condition and conformance with this specification permits;
 - (a) valves and operators,
 - (b) dampers and operators,
 - (c) compressed air system,
 - (d) thermocouple wells,
 - (e) freezestats,
 - (f) firestats,
 - (g) limit, end, or level switches and air or liquid flow switches,
 - (h) static pressure sensors and controllers,
 - (i) wiring and conduit for safety controls and I/O points,
 - (j) relays,
 - (k) cabinets,
 - (l) other items specifically noted as existing, to be re-used.
- .2 Remove and replace existing temperature and humidity sensors with new units, throughout the installation,
- .3 Check and re-calibrate existing indicator gauges,
 - .1 under no circumstances are existing gauges or thermometers be removed.
- .4 Re-calibrate valves and dampers as part of installation of this system.
- .5 Existing thermowells for conventional control system may be reused for new sensors,
 - .1 repack temperature wells, both new and reused, with heat conductive grease.

3.2 Existing Programming and Configuration

- .1 Document existing control device programming, configuration, and setpoint values at the start of the work, prior to any demolition or other work on existing control equipment.

- .2 For each NSC or ASC being replaced, review the existing control programming and/or configuration settings, and prepare a written sequence of operation in laymen terms that describes the operating control of each control device. Where multiple control devices of the same type exist (e.g. terminal units), review at least three (3) randomly selected controllers to verify the same control functions; a single written control sequence for each type controller is sufficient.
- .3 Provide a copy of these documentation to the Owner.
- .4 Except where otherwise specified for new sequence of operations, program and/or configure software for replacement NSC and ASC to achieve the same control functionality and sequence of operation of the pre-existing NSC and ASC controllers, and configure setpoints to match pre-existing controller values.

3.3 Existing Condition Survey

- .1 Conduct a condition survey of existing control devices:
 - .1 test, inspect and report on existing devices which are to be incorporated into the BAS, for satisfactory operation within 30 days of award of contract and prior to installation of any new devices,
 - .2 for those items found in unacceptable condition, provide with report test data, original specification sheets or written functional requirements to confirm conclusion,
 - .3 Owner to arrange for repair or replacement of those existing items judged defective, but shown to be re-used in BAS and control system,
 - .4 items thus repaired or replaced by Owner will be returned to site and handed over to Contractor under this Section for storage, installation, testing, and commissioning.,
 - .5 warrant reused devices that have been rebuilt or repaired. Demonstrate satisfactory operating condition of reused devices at time of acceptance,
 - .6 responsibility for existing control devices that have been reused is to terminate at end of warranty period.

3.4 Demolition and Removals

- .1 Unless specifically noted or shown otherwise, remove existing control components made redundant:
 - .1 room thermostats, controllers, auxiliary electronic devices, pneumatic controllers and relays, control valves, electronic sensors, and transmitters: to be removed and placed in storage as directed by Owner.
 - .2 local control panels: removed and placed in storage as directed by Owner.
- .2 Remove and dispose of existing conduits, wiring and tubing in all areas (including above accessible ceilings) as they become redundant;
 - .1 remove existing control compressed air systems and, where applicable, connect to new control air system;
 - .2 existing hardwired interlocks to remain installed in systems.
- .3 In existing areas not otherwise involved in renovations, arrange and pay for holes and marks left by decommissioning and removal of control components, wiring, conduit, and tubing to be patched and refinished to match existing.

3.5 Maintaining Existing System Operation

- .1 Mechanical systems to remain in operation and to maintain space conditions between hours of 6 a.m. and 9 p.m., Monday through Friday.

- .2 In these periods mechanical control system shut downs of up to 15 minutes may be permitted, after obtaining written agreement from Owner.
- .3 When time required for cut-over of controls will not meet these constraints, perform work outside of operating hours after making application; outlining areas affected; and likely length of interruption, and obtain written agreement from Owner. .
- .4 Maintain fan scheduling using existing or temporary time clocks or control systems throughout period of control system installation.
- .5 Modify existing motor controllers to incorporate new local operator control switches for motors to be controlled through BAS system.

3.6 Installation of New Thermowells

- .1 Existing piping services to remain in service during installation of thermowells.
- .2 Coordinate with the trade contractor under Division 23 to install thermowells for new temperature sensors mounted on steel piping by hot-tapping in accordance with specification section 20 05 26.

3.7 Interfacing Between New and Existing Control Systems

- .1 Certain building systems are to operate in event of building power failure or fire alarm. Under no circumstances should interfacing of equipment or controls modify these existing sequences of operation.
- .2 Where tying new system into existing control equipment, show on shop drawings;
 - .1 signal levels,
 - .2 wire type,
 - .3 wire numbers, and
 - .4 terminal numbers.
- .3 Before attempting replacement of existing control systems, install new field panels, controllers and associated devices loose-ended ready for system changeover.
- .4 Submit written request to Owner setting out proposed starting time for changeover, duration of system down time, and establishing extent of interruption to operation of existing control system.
- .5 Do not proceed with work until Owner's written approval of time for, duration of, and extent of interruption is received.
- .6 Subsequent decommissioning and removal of control components to be carried out without interfering with normal operations or creating an interruption in service of any building systems except through an approval process similar to that noted above.

End of Section

BUILDING AUTOMATION CONTROL PANELS AND WIRING

25 05 12

1 GENERAL

1.1 Scope

- .1 Provide building automation control panels for mounting and securing building automation control equipment and devices.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 12 Common Electrical Requirements for Mechanical Services
 - .2 25 30 16 Building Automation Instrumentation

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Control wiring** – has the meaning as defined in specification section 20 05 12.
 - .2 **Extra-low voltage** – any voltage not exceeding 30 V (has the same meaning as per CSA C22.1)
 - .3 **GUI** means “graphic user interface”, to display system data to the user and to allow the user to enter operating commands and data selection.
 - .4 **Power wiring** - has the meaning as defined in specification section 20 05 12.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 0.3 Test Methods for Electrical Wires and Cables
 - .2 CSA C22.2 No. 14 Industrial Control Equipment
CSA C33.3 No. 18.5/UL 1565
Positioning Devices
 - .3 CSA C22.2 No. 66.2 Low Voltage Transformers – Part 2: General Purpose Transformers
CSA C22.2 No. 66.3 / UL 5085-3
Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers
 - .4 CSA C22.2 No. 72 Heater Elements
 - .5 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .6 CSA C22.2 No. 223 Power Supplies with Extra-Low-Voltage Class 2 Outputs.

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.6 Registration and Inspection

- .1 Where control panels are not listed in accordance with CSA C22.2 No. 14, arrange and pay for field inspection by the AHJ for electrical safety.

1.7 Submittals

- .1 Shop drawings:
 - .1 submit product data sheets for materials specified herein.
 - .2 submit shop drawings for control panels including wiring diagrams and panel layout details.

2 PRODUCTS

2.1 General

- .1 Provide custom factory-made building automation control panels including all factory-installed devices and equipment required for operation of associated building equipment or systems including but not limited to DDC controllers, GUI, power supplies, transducers, solenoid air valves, relays and accessories.
- .2 Comply with the requirements of specification section 20 05 12 for products not otherwise specified herein.
- .3 Provide equipment which functions and meets detailed performance criteria when operating under the following conditions:
 - .1 ambient temperature:
 - (a) indoors: 4°C to 40°C (39°F to 104°F)
 - (b) outdoors: -30°C to + 40°C (-22°F to 104°F)
 - .2 ambient relative humidity: 10% to 90% non -condensing,
 - .3 electrical power service: 120 VAC +/- 10%, 1 phase, 60 Hz nominal.

2.2 Control Panels

- .1 Panel enclosure:
 - .1 indoors: type 2 with sprinkler shield, 3R or 4 to CSA C22.2 No. 94.1 (NEMA 2, 3R, or 4),
 - .2 material: galvanized steel,
 - .3 with hinged door and lock,
 - .4 integral cooling fans and vents with power supplies, wiring and circuit protection,
 - .5 mounting backplate and/or DIN rails for mounting of wiring devices, controllers, sensors, transducers, and relays,
 - .6 conduit openings and adapters in sufficient quantities and sizes to accommodate wiring terminating within enclosure,
 - .7 document holder inside panel, to include one set of as built, plasticized control Shop Drawings for equipment served by that panel permanently affixed to cabinet frame,
 - .8 enclosure finish: vendors standard colour,
- .2 GUI display:
 - .1 surface mounted on or semi-recessed in panel front door where GUI is required by other specification sections of Division 25.
 - .2 where GUI is mounted on the controller inside the panel, provide panel door cut-out with viewing glass to allow viewing only of GUI with panel door closed.
- .3 Control panel layout and construction:
 - .1 enclosures to be of sufficient size to house control components including controllers and associated transformers, control relays, wiring, conduits and other auxiliary equipment, so as to

- allow access for maintenance and replacement of components without requiring removal of other components.
- .2 permanent engraved labels with black lettering on white background indicating;
 - (a) stating applicable building system name and reference number.
 - (b) function of each panel door mounted device.
- .3 mount air pressure gauges on front of panel door to allow viewing from outside the panel,
- .4 support wiring in cable ducts; arrange cable ducting and install wiring in a neat and workmanlike manner,
- .5 provide numbered terminal strips for field wiring terminations; do not terminate field wiring directly on control devices or controllers. Arrange terminal strips in a common location adjacent to minimize routing and quantity of field wiring inside of panel.
- .6 label both ends of internal wiring with label markers using name of cable function, or to identify wire number as shown on panel shop drawings,
- .7 layout circuit fuses to facilitate location and replacement; provide labels at each fuse holder identifying fuse number and replacement fuse type and size,
- .4 Control devices mounted on panel door-front:
 - .1 Key-lock operated main panel power ON-OFF switch,
 - .2 alarm buzzer silence pushbutton (where applicable),
 - .3 alarm reset pushbutton (where applicable),
 - .4 indicating lights:
 - (a) main panel power ON (white),
 - (b) summary alarm (red),
 - (c) other indicating lights as specified by control sequences.
- .5 Panel mounted alarm devices:
 - .1 alarm buzzer (where applicable).
- .6 Cable Ducts
 - .1 non-metallic cable ducting with removable cover, slotted access cable restraints,
 - .2 ambient temperature rating: -40 to +60°C (-40 to +140°F)
 - .3 listed to CSA C33.3 No. 18.5/UL 1565.
- .7 Terminal strips:
 - .1 NEMA finger-safe terminal blocks, spring-clamp or screw fastened,
 - .2 directly fastened to panel backplane or DIN rail mounted.

2.3 Power Supplies and Line Filtering

- .1 For control panels and for field installed devices.
- .2 Transformers and Power Supplies:
 - .1 industrial control transformers to be listed to CSA C22.2 No. 66-2, and temperature rated for 40°C,
 - .2 control transformers to be listed to CSA C22.2 No. 66-3,
 - .3 AC/DC power supplies to be listed to CSA C22.2 No. 223,
 - .4 provide over-current protection in primary and secondary circuits,
 - .5 limit connected loads to 80% of rated capacity.

- .3 DC power supplies:
 - .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 to 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 to operate between 0°C and 50°C (32°F and 120°F).
 - .5 EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
- .4 Power Line Filtering:
 - .1 provide internal or external transient voltage and surge suppression for workstations and control modules,
 - .2 surge protection:
 - (a) dielectric strength of 1000 V minimum,
 - (b) response time of 10 nanoseconds or less,
 - (c) transverse mode noise attenuation of 65 dB or greater,
 - (d) common mode noise attenuation of 150 dB or greater at 40-100 Hz.

2.4 Miscellaneous Electrical Control Devices

- .1 Control Relays:
 - .1 plug-in type, UL listed, with dust cover and LED "energized" indicator.
 - .2 contact rating, configuration, and coil voltage suitable for application.
 - .3 NEMA 1 enclosure for relays not installed in local control panels.
- .2 Time Delay Relays:
 - .1 solid-state plug-in type, UL listed, with adjustable time delay adjustable $\pm 100\%$ from set point shown.
 - .2 contact rating, configuration, and coil voltage suitable for application.
 - .3 NEMA 1 enclosure for relays not installed in local control panels.
- .3 Override Timers:
 - .1 spring-wound line voltage, UL Listed, with contact rating and configuration by application unless implemented in control software.
 - .2 0-6 hour calibrated dial.
 - .3 flush mounted on local control panel face.
- .4 Electronic signal isolation transducers:
 - .1 provided whenever;
 - (a) an analog output signal from BAS is connected to an external control system as an input (such as chiller control panel) or
 - (b) BAS is to receive an analog input signal from an external remote system.
 - .2 designed for ground plane isolation between systems.

2.5 Electro-Pneumatic (E/P) Transducers

- .1 To convert 4-20 mA, 0-5 Vdc, or 0-10 Vdc analog control input signal to a 20-100 kPa (3-15 psig) output signal;
 - .1 separate span and zero adjustments,
 - .2 manual output adjustments,
 - .3 output pressure gauge assembly,
 - .4 feedback loop control,
 - .5 mid-range air consumption of 0.05 NL/s (0.1 SCFM).

2.6 Pressure-Electric (P/E) Switches

- .1 To convert pressure signal to activate electric switch;
 - .1 diaphragm operated SPDT. snap acting contacts with electrical rating suitable for application,
 - .2 designed to withstand up to 170 kPa (25 psi) input pressure,
 - .3 adjustable cut-in and cut-out settings between 25 and 140 kPa (3 and 20 psi).

2.7 Additional Requirements for Outdoor Panels

- .1 The following additional requirements apply where control panels are installed outdoors, or indoors in unheated spaces.
- .2 Enclosure: type 4, 4X or 12 to CSA C22.2 No. 94.1 (NEMA 4, 4X or 12),
- .3 Thermally insulated on all interior surfaces
 - .1 minimum thickness: 25 mm (1 in) at a maximum thermal conductivity of 0.0365 W/mK (0.0211 Btuh/ft²F) , or equivalent minimum RSI= 0.68 m²K/W (R = 3.86 ft²F/BTUH).
- .4 Mount GUI and other front-mount devices on inner front panel behind main panel door.
- .5 Electric resistance panel heater:
 - .1 electric resistant heaters listed to CAN/CSA C22.2 No. 72,
 - .2 sized to maintain panel interior temperature at not less than 4.5°C (40°F), at the ambient design temperature.
 - .3 integral or line mounted thermostat control, set with a temperature deadband of ON at 4.5°C (50°F) and OFF at 12°C (55°F).

2.8 Wiring and Raceways

- .1 Electrical materials, equipment and installation procedures to conform to the electrical safety code applicable to the location of the Work, in accordance with the requirements of specification section 20 05 12, and as specified herein.
 - .1 conductors for digital functions: 18 AWG minimum, twisted and shielded,
 - .2 conductors for analog functions: 18 AWG minimum, twisted and shielded, 2 or 3 wire to match analog function hardware.
 - .3 conductors for transformer current wiring: 16 AWG minimum,
 - .4 conductors for sensor wiring: 22 AWG minimum, twisted and shielded, 2 or 3 wire to match analog function hardware. Provide additional conductors as to support supplemental features of sensor (i.e. set-point adjustment, override, etc.).
- .2 Non-continuous cable supports:
 - .1 Sling strap:

- (a) Galvanized steel support bracket with adjustable polyethylene support sling.

Standard of Acceptance

- nVent – fig. Caddy Cable 425

3 EXECUTION

3.1 Control Panel Installation

- .1 Install transmitters, transducers, controllers, solenoid air valves and relays in control panels.
- .2 Mount control panels to poured concrete or concrete block walls on mounting channels; do not fasten directly to the wall.
- .3 Where control panels are located away from concrete walls, provide a fabricated floor-mounted galvanized-steel channel support frame to mount control panels. Design support frame to withstand applicable seismic loads.
- .4 Install control panels with user interface devices on the panel door so that the centerline of the principle interface device is between 1500 and 1600 mm (60 to 64 in) above floor level.
- .5 Install other panels so that the top of the panel is located between 1800 and 1900 mm (72 to 76 in) above the floor.
- .6 Trim-back or neatly collect excess field wiring inside of control panels.

3.2 Field Wiring Installation

- .1 Provide power wiring and control wiring as needed to support operation of the building automation system. Refer to Section 20 05 12 for description of division of work and responsibility.
- .2 Installation of field wiring for power wiring and control wiring to conform to specification section 20 05 12 except/and as specified herein.
- .3 During installation follow cable manufacturer's specified cable pulling tension, and recommended minimum bend radius.
- .4 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- .5 Install lightning arrester according to manufacturer's recommendations between cable and ground wherever cable enters or exits the building.
- .6 Each run of communication wiring to be continuous length without splices.
- .7 Label communication wiring to indicate origin and destination.
- .8 Ground coaxial cable according to Division 26 requirements.
- .9 Fiber optic cable installation:
 - .1 do not exceed pulling tensions specified by cable manufacturer. Post-installation residual cable tension to be in accordance with cable manufacturer's specifications,
 - .2 do not exceed minimum cable and unfaceted fiber bend radii specified by cable manufacturer.

3.3 Conduit and Raceways

- .1 Run power wiring and control wiring in conduit except where otherwise specified herein.
- .2 Extra-low voltage control wiring located in horizontal service spaces above dropped ceilings may be run exposed (without conduit) provided that wiring is;
 - .1 installed neatly and parallel to building lines,

- .2 supported from J-hooks at intervals not exceeding 1200 mm (4 ft),
- .3 have a FT6 rating in accordance with CSA C22.2 NO. 0.3 when installed in a supply or return air ceiling plenum
- .3 Do not run any BAS wiring in IT infrastructure cable trays
- .4 Run conduit and raceways parallel to building lines and be secured to building structure.
- .5 Where conduit leaves heated areas and enters unheated areas, seal conduit with weather-tight sealant at the first junction box in the unheated space.

3.4 Power Conversion and Control Relays

- .1 Provide interposing and motor control relays at local item of equipment or at associated MCC as applicable.
- .2 Provide control transformers and power supplies for system components requiring power supply that do not have integral control transformers.
- .3 Where point schematics and specifications indicate auxiliary contact provision, provide instrumentation, wiring, conduit, power supplies and services as to integrate these points into BAS.
- .4 Mount transformers in enclosures adjacent to equipment served.

3.5 Cleaning

- .1 Prior to handover to the Owner, remove all debris from and vacuum clean inside of control panels. Clean exterior surfaces of panels including GUI displays.

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

BUILDING AUTOMATION ACTUATORS AND OPERATORS 25 30 13

1 GENERAL

1.1 Scope

- .1 Provide actuators and operators for building systems automation.
- .2 Provide actuators for operating control dampers provided as part of factory built air handling units.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 35 13 Terminal Units
 - .2 25 05 01 Building Automation Common Work Results
 - .3 25 30 23 Building Automation PICV and Energy Valves
 - .4 25 30 26 Building Automation Control Valves
 - .5 25 30 33 Building Automation Control Dampers
 - .6 25 35 26 Building Automation Compressed Air Supply

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Emergency equipment** means engine-driven electrical generators and diesel-engine driven fire pumps.
 - .2 **Terminal units** has the meaning in accordance with specification section 23 35 13.
 - .3 **Valves** means a water, glycol, or steam control valve in accordance with specification sections 25 30 23 or 25 30 26.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 24 Temperature-Indicating and -Regulating Equipment
 - .2 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .3 CAN/CSA-E60730-2-14 Automatic Electrical Controls - Part 2: Particular Requirements for Electric Actuators

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in the following minimum ambient condition ranges except where otherwise specified:
 - .1 ambient temperature:

Actuator Location	Service Temperature Range	Notes
Indoor	4°C to 40°C	(a)

Actuator Location	Service Temperature Range	Notes
Outdoor	(-22°F to 104°F)	
Intake and exhaust air plenums	(-22°F to 104°F)	

Notes:

- (a) *Unheated spaces to be treated as outdoor spaces.*
- (b) *Temperature ratings may be met by use of heated actuator enclosure.*

- .2 Ambient relative humidity 10% to 90% non -condensing
- .2 Components installed within motor controllers to be designed to operate with transient electrical fields occurring within these devices.

2.2 Damper Actuators - General Purpose Electric/Electronic

- .1 General purpose damper actuators for air handling unit dampers and plenum/duct mounted dampers.
- .2 Listed to CAN/CSA-E60730-2-14.
- .3 Control action:
 - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
 - (a) floating-point modulation not acceptable.
- .4 Enclosure:
 - .1 Type 2 to CSA C22.2 No. 94.1, or NEMA 2, for indoor applications,
 - .2 Type 4 or 12 to CSA C22.2 No. 94.1 or NEMA 4 or 12, for outdoor use and where dampers are exposed to the airstream inside an air intake plenum.
- .5 Construction:
 - .1 gear type mechanism with spring-return to failed position, or electronically fail-safe,
 - .2 adjustable motor rotation direction,
 - .3 mechanical position indicator,
 - .4 directly mounted to damper shaft,
 - (a) remote mounted with connecting linkage and with fastening clamp assembly are permitted only where there is insufficient space for mounting actuator directly onto damper shaft.
 - .5 electronic overload or digital rotation sensing circuitry to protect damper operator through entire range of rotation,
 - .6 angle of rotation adjustable between 0° to 90°,
 - .7 input control signals:
 - (a) proportional-modulation service: 0 - 10V, 2-10 V, or 0 - 20mA,
 - (b) two position service: power On-Off
 - .8 feedback signals:
 - (a) proportional-modulating service: 2 - 10 V position feedback signal.
 - (b) two position service: two (2) x SPDT auxiliary switches for end stop position indication (open and closed), 3 A resistive @ 250 VAC
 - .9 power supply:
 - (a) modulating service: 24 VAC/VDC, 50/60 Hz.

(b) two position service: 120 VAC or 24 VAC.

.6 Selection:

- .1 sized and selected in accordance with manufacturer's instructions,
- .2 minimum torque rating for dampers: sufficient to operate damper to provide smooth response up to fan dead-head pressure plus 15%,

2.3 Damper Actuators - Specific Purpose Electric/Electronic for Emergency Equipment

- .1 Specific purpose damper actuators for ventilation dampers serving emergency equipment.
- .2 Type: as above for general purpose damper actuators and as follows.
- .3 Operating temperature: -40°C to + 50°C (-40°F to 122°F).
- .4 Control action:
 - .1 spring return to fail position on loss of power supply:
 - (a) combustion air dampers : fail-to-open
 - (b) ventilation inlet air dampers: fail-to-open
 - (c) recirculation air dampers: fail-to-close
 - (d) exhaust air dampers: fail-to-open.
 - .2 spring operating cycle time: <20 seconds at -20°C to 50°C (-4°F to 122°F)
- .5 Enclosure:
 - .1 integral heating element for low temperature operation, 24 VAC.
- .6 Operating control:
 - .1 combustion air dampers: two position open/closed
 - .2 all other dampers: proportional-modulating with 0-10VDC or 4-20 mA input signal

Standard of Acceptance

- Belimo - EFB24-S N4/EFB120-S N4 series for two position dampers
- Belimo - EFB24-SR-S N4 series for modulating dampers

2.4 Damper Actuators - Specific Purpose Electronic for Terminal Units

- .1 Specific purpose damper actuators for terminal units.
- .2 Listed to CAN/CSA-E60730-2-14.
- .3 Control action:
 - .1 proportional-modulating type control,
- .4 Enclosure:
 - .1 Type 2 to CSA C22.2 No. 94.1, or NEMA 2, for indoor applications,
- .5 Construction:
 - .1 gear drive, direct coupled type operators mounted to terminal box damper shaft with universal V-bolt clamp,
 - .2 selectable / reversible rotation direction,
 - .3 input type and range as suitable for interfacing to output of terminal unit controller,
 - .4 angle of rotation adjustable between 0 to 90° with adjustable mechanical limit stops,
 - .5 damper position indication visible without cover removal,

- .6 manual override to set damper position without power applied to actuator,
- .7 electronic stall protection,
- .8 actuator running time of not more than 100 seconds,
- .9 failure mode on loss of power to the actuator:
 - (a) non-smoke control or smoke venting applications: fail in last position,
 - (b) smoke control or smoke venting applications: spring return, Fail-Open, Fail-Close, failure position as detailed in control sequence requirements.
- .10 power supply: 24 VAC/VDC, 50/60 Hz.
- .6 Selection:
 - .1 sized and selected in accordance with terminal unit manufacturer's requirements.

2.5 Valve Actuators - General Purpose Electric/Electronic

- .1 General purpose valve actuators for liquid and steam control valves for ball valves and globe valves.
- .2 Listed to CAN/CSA-E60730-2-14 or CSA C22.2 No. 24.
- .3 Control action:
 - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
 - (a) floating-point modulation not acceptable,
 - .2 rotary or linear acting to suit valve action.
- .4 Enclosure:
 - .1 Type 2 to CSA C22.2 No. 94.1, or NEMA 2, for indoor applications,
 - .2 Type 4 or 12 to CSA C22.2 No. 94.1 or NEMA 4 or 12, for outdoor use and where dampers are exposed to the airstream inside an air intake plenum.
- .5 Construction:
 - .1 high alloy gear type mechanism with spring-return to failed position, or electronically fail-safe,
 - .2 adjustable motor rotation direction,
 - .3 mechanical position indicator,
 - .4 directly mounted to valve shaft, or with linear linkage drive assembly,
 - .5 compatible for installation on ISO 5211 mounting pad,
 - .6 electronic overload or digital rotation sensing circuitry to protect actuator through entire range of rotation,
 - .7 running time: < 160 seconds, independent of load,
 - .8 input control signals:
 - (a) proportional-modulation service: 0 - 10V, 2-10 V, or 0 - 20mA,
 - (b) two position service: power On-Off
 - .9 feedback signals:
 - (a) proportional-modulating service: 2 - 10 V position feedback signal.
 - (b) two position service: two (2) x SPDT auxiliary switches for end stop position indication (open and closed), 3 A resistive @ 250 VAC
 - .10 power supply:

- (a) modulating service: 24 VAC/VDC, 50/60 Hz.
- (b) two position service: 120 VAC or 24 VAC.

.6 Selection:

- .1 sized and selected in accordance with valve manufacturer's instructions,
- .2 minimum torque ratings for valves: sufficient to suit valve opening or closing requirements against a fluid differential pressure on:
 - (a) closed loop piping system of not less than 280 kPa (40 psig), plus 15%.
 - (b) open loop piping systems of not less than 700 kPa (100 psig), plus 15%.
- .3 actuators may be supplied as multiple units to achieve required torque.

2.6 Valve Actuators - Specific Purpose Electric/Electronic for Large Valves

- .1 Specific purpose valve actuators for large rotary operation butterfly valves with high torque requirements.
- .2 Listed to CAN/CSA-E60730-2-14 or CSA C22.2 No. 24.
- .3 Ambient temperature: -40°C to + 40°C (-40°F to 104°F),
- .4 Control action:
 - .1 electric/electronic operation for two position (OPEN-CLOSE) and proportional-modulating operation as shown,
 - (a) floating-point modulation not acceptable,
- .5 Enclosure:
 - .1 die-cast aluminum alloy,
 - .2 Type 4X to CSA C22.2 No. 94.1 or NEMA 4 or 12.
 - .3 integral heating element for internal humidity control and low temperature operation, same voltage as actuator motor.
- .6 Construction:
 - .1 single or dual-winding bidirectional motor driven actuator,
 - .2 spring-return or electronically fail-safe to failed position,
 - .3 self-locking high alloy steel gear type mechanism,
 - .4 electronic interface control board, solid state drive,
 - .5 span and zero travel adjustment,
 - .6 adjustable motor rotation direction,
 - .7 mechanical position indicator,
 - .8 directly mounted to valve shaft,
 - .9 compatible for installation on ISO 5211 mounting pad,
 - .10 thermal or electronic overload to protect actuator through entire range of rotation,
 - .11 running time: < 60 seconds, independent of load,
 - .12 duty cycle:
 - (a) On/Off valves: minimum 30%
 - (b) Proportional valves: minimum 75%
 - .13 declutching handwheel override,

- .14 valve position indicator,
- .15 input control signals:
 - (a) 0 - 10VDC or 0 - 20mA for proportional-modulation control,
 - (b) power On-Off for two position service,
- .16 feedback signals:
 - (a) proportional-modulating service: 2 - 10 V position feedback signal.
 - (b) two position service: two (2) x SPDT auxiliary switches for end stop position indication (open and closed), 3 A resistive @ 250 VAC
- .17 power supply:
 - (a) modulating service: 24 VAC/VDC or 120 VAC, 50/60 Hz.
 - (b) two position service: 120 VAC or 24 VAC, 50/60 Hz.
- .7 Selection:
 - .1 sized and selected in accordance with valve manufacturer's instructions,
 - .2 minimum torque ratings for valves: sufficient to suit valve opening or closing requirements against a fluid differential pressure on:
 - (a) closed loop piping system of not less than 280 kPa (40 psig), plus 15%.
 - (b) open loop piping systems of not less than 700 kPa (100 psig), plus 15%.

2.7 Valve and Damper Actuators - Pneumatic

- .1 Construction:
 - .1 piston and rolling diaphragm type or diaphragm type rated for operating pressure and not less than 140 kPa (20 psig).
 - .2 replaceable diaphragm: molded neoprene,
 - .3 pressure rating: 1030 kPa (150 psi)
 - .4 operating signal pressure range: 0-140 kPa (0-20 psi)
- .2 Enclosure (housing):
 - .1 housings: molded or die-cast from zinc or aluminum,
 - .2 housings for terminal unit air control damper actuators and for actuators for valves on radiation, radiant panels or terminal reheat coils,
 - (a) of high-impact plastic construction ,
 - (b) isolated from return air plenums with auxiliary metal enclosures having quick-opening access panels.
- .3 Pneumatic controller:
 - .1 pilot positioners;
 - (a) smooth modulation and sequencing,
 - (b) high-capacity force balance relay type with suitable mounting provisions,
 - (c) position feedback linkage tailored for actuator,
 - (d) use full control air pressure at any point in stem travel to initiate stem movement or to maintain stem position,
 - (e) operate on 20-100 kPa (3-15 psig) input signal,
 - .2 performance characteristics;

- (a) linearity: $\pm 10\%$ of output signal span.
 - (b) hysteresis: 3% of span.
 - (c) response: initiated by not more than 1.7 kPa ($\frac{1}{4}$ psig) input change.
 - (d) maximum pilot signal pressure: 140 kPa (20 psig).
 - (e) maximum control air supply pressure: 420 kPa (60 psig).
- .4 For sequencing terminal unit air control damper actuators and actuators on valves for radiation, radiant panels or terminal reheat coils;
- .1 use spring ranges selected to prevent overlap, or use positive positioners.
- .5 Selection:
- .1 selected in accordance with damper or valve manufacturer's instructions,
 - .2 of sufficient torque rating to operated damper or valve with smooth action at proper response speed,
 - .3 minimum torque rating for dampers: sufficient to operate damper to provide smooth response up to fan dead-head pressure plus 15%,
 - .4 minimum torque ratings for valves: sufficient to suit valve opening or closing requirements against a fluid differential pressure on:
 - (a) closed loop piping system of not less than 280 kPa (40 psig), plus 15%.
 - (b) open loop piping systems of not less than 700 kPa (100 psig), plus 15%.

3 EXECUTION

3.1 Application

- .1 Use electric/electronic actuators for damper and actuators except for:
 - .1 replacement of existing valves that will remain as pneumatic control,

3.2 Installation

- .1 General:
 - .1 Mount actuators and provide adapters according to manufacturer's recommendations.
- .2 Electric and Electronic Damper Actuators:
 - .1 Mount damper actuators directly on damper shaft or jackshaft; linkages may be used only where there is insufficient space to install and remove the actuator directly on the damper shaft.
 - .2 Mount valve actuator directly on shaft or with linkages according to manufacturer's recommendations.
 - .3 For low-leakage dampers with seals, mount actuator with minimum 5° travel available for damper seal tightening.
 - .4 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close damper, then tighten linkage.
 - .5 Provide mounting hardware and linkages for actuator installation.
- .3 Pneumatic damper actuators:
 - .1 Check operation of damper-actuator combination to confirm that actuator modulates damper or valve smoothly throughout stroke to both open and closed positions.
 - .2 Mount positive pilot positioners directly to pneumatic actuators with pressure gauges for supply input and output pressures.

- .3 Total damper area operated by each actuator to not exceed 80% of manufacturer's maximum area rating.
- .4 For axially aligned damper sections, use line shafting or line shaft couplings (jack shafting).

3.3 Power and Control Wiring

- .1 Provide power and control wiring to each electric/electronic operator in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.
- .2 Where required by actuator manufacturer instructions for parallel actuator installation, provide power isolation relays to isolate forward and reverse motor windings.

3.4 Compressed Air

- .1 Provide compressed air service to each pneumatic actuator in accordance with specification section 25 35 26.
- .2 Provide a manual isolation valve for each actuator.

3.5 Testing

- .1 Test each actuator by applying appropriate control signal and inspect for smooth operation while operating under normal load conditions.
- .2 Alternatively, where there are more than ten (10) actuators serving the same application, a timed cycle test may be used for all valves in each application:
 - .1 randomly select ten samples for each application, and measure open and closed timing of the sample valve set, and then estimate the average time of the set.
 - .2 Using the BAS, cycle open and then closed and record the time duration for each half cycle for each actuator. Test acceptance criteria is where each damper opens and closes within 90% of the tested average time.

End of Section

BUILDING AUTOMATION INSTRUMENTATION

25 30 16.13

1 GENERAL

1.1 Scope

- .1 Provide measurement switches, sensors, and transmitter instrumentation for building automation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 01 13 Definitions and Abbreviations – Mechanical
 - .2 25 05 01 Building Automation Common Work Results

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Finished rooms/spaces** means a room or space that is not a service room.
 - .2 **Instrumentation** means products covered by this specification section.
 - .3 **Service rooms** has the meaning as defined in specification section 20 01 13.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code
- .2 Product standards:
 - .1 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations.

1.5 Design Criteria

- .1 Pressure rating of instrumentation connected to pressure piping to be equal to or greater than the design pressure at the design temperature of the associated piping system.

1.6 Submittals

- .1 Submit manufacturer product data sheets in accordance with the requirements of Division 01.
- .2 Include Canadian Registration Numbers for applicable products.

1.7 Quality Control

- .1 Products that are in contact with the process fluid of a piping system that is subject to registration under applicable boiler and pressure vessel legislation are to have Canadian Registration Numbers in accordance with CSA B51.

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in the following minimum ambient condition ranges except where otherwise specified:
 - .1 ambient temperature:

Instrument Location	Service Temperature Range	Notes
Indoor	4°C to 40°C (39°F to 104°F)	(a)
Outdoor	-30°C to + 40°C (-22°F to 104°F)	
Outdoor	-40°C to + 40°C (-40°F to 104°F)	(b)
Intake and exhaust air plenums	-30°C to + 40°C (-22°F to 104°F)	
Intake and exhaust air plenums (with enclosure heater)	-40°C to + 40°C (-40°F to 104°F)	(b)
Emergency equipment intake and exhaust air plenums	-40°C to + 50°C (-40°F to 122°F)	(b)

Notes:

(a) Unheated spaces to be treated as outdoor spaces.

(b) Temperature ratings may be met by use of heated actuator enclosure.

- .2 Ambient relative humidity 10% to 90% non -condensing
- .2 Components installed within motor controllers to be designed to operate with transient electrical fields occurring within these devices.

2.2 Temperature Switches

- .1 Low temperature limit temperature switch:
 - .1 6m (20 ft) of sensing capillary sensitive to freezing air over any 400mm (15 in) section,
 - .2 automatic reset with fixed differential temperature,
 - .3 installed in multiples with one unit serving not more than 5 m² (40 sq. ft) of duct area.
 - .4 single pole double throw (SPDT) contacts,
 - .5 operating temperature range: 1.7°C to 7.2°C (35°F to 45°F),
 - .6 adjustable set point within specified range,
 - .7 protective enclosure.
- .2 Temperature switches:
 - .1 sensing element of liquid, vapour or bimetallic type,
 - .2 adjustable set-point and differential of at least 0.22°C to 1.7°C (0.4°F to 3.0°F),
 - .3 snap action type rated at 120 volts, 15 amps or 24 volts DC,
 - .4 automatic in-operation and automatically reset when condition returns to normal,
 - .5 type:
 - (a) suitable for wall mounting on standard electrical box with protective guard, or suitable for insertion into air ducts with insertion length of 450 mm (18 in), or
 - (b) thermowell type with compression fitting for 20 mm (0.8 in) NPT well, mounting length of 100 mm (4 in), and immersion wells of type 316 stainless steel, or
- .3 Strap-on-type temperature switch with helical screw stainless steel clamps:
 - .1 operating temperature range: 23°C to 57°C (75°F to 138°F)
 - .2 adjustable set point within specified range,
 - .3 single pole double throw (SPDT) contacts,

- .4 protective enclosure.

2.3 Temperature Sensors – General Requirements

- .1 Sensor element types:
 - .1 Resistance temperature device (RTD) of precision thin film platinum element type;
 - (a) linear characteristics over sensor range,
 - (b) reference resistance: 1000 ohm, ± 20 ohms (2%) ± 2 ohms (0.2%) at 0°C (32°F),
 - (c) temperature resistance coefficient: 0/.0385 ohms/ohm/°C (0.0212 ohms/ohm/°F),
 - (d) accuracy: $\pm 0.36^\circ\text{C}$ at 21°C ($\pm 0.65^\circ\text{F}$ at 70°F) accuracy to Din IEC 751
 - .2 Resistance temperature device (RTD) of precision thin film nickel element type;
 - (a) linear characteristics over sensor range,
 - (b) reference resistance: 1000 ohm, ± 20 ohms (2%) ± 2 ohms (0.2%) at 21°C (70°F),
 - (c) temperature resistance coefficient: 5.4 ohm/°C (3.0 ohm/°F)
 - (d) accuracy: $\pm 0.18^\circ\text{C}$ at 21°C ($\pm 0.34^\circ\text{F}$ at 70°F)
 - .3 Thermistor;
 - (a) non-linear negative temperature coefficient of resistance,
 - (b) reference resistance: 10,000 ohms at 25°C (77°F),
 - (c) accuracy: curve matched to $\pm 0.2^\circ\text{C}$ ($\pm 0.36^\circ\text{F}$) over 0°C to 70°C (32°F to 158°F),
 - (d) long term stability: 0.025°C (0.045°F) drift per year
- .2 Sensor construction general requirements:
 - .1 2 integral anchored lead wires,
 - .2 waterproof sensor to sheath seal,
 - .3 strain minimizing construction,
 - .4 standard conduit box termination with cover,
 - .5 pig-tail wire leads with wire nuts or screwed terminal connector block,
 - .6 factory calibrated and capable of end to end (sensing element to BAS) accuracy of $\pm 0.25^\circ\text{C}$ ($\pm 0.5^\circ\text{F}$) over full range of measured variable,
 - .7 transducing circuit to convert output to signal compatible with equipment controller.

2.4 Temperature Sensors – for Ducts and Piping

- .1 For installation in duct and piping systems.
- .2 Averaging element type temperature sensors:
 - .1 averaging style element sensors, with minimum of four (4) encapsulated platinum 1 kohm RTD sensors per length,
 - .2 bendable aluminum or copper tubing construction,
 - .3 sensor operating temperature range from -40°C to 121°C (-40°F to 250°F).
 - .4 ambient relative humidity: 5 to 95% RH non-condensing,
 - .5 minimum immersion length: 1800 mm (6 feet).
 - .6 probe field-formable to minimum radius of 100mm (4 in) at any point along probe length, other than with 200 mm (8 in) of connector box, without degradation of specified performance,
 - .7 galvanized steel or polycarbonate junction box,

- .8 provided as multiple RTD sensors where single averaging element cannot be located to provide proper duct or plenum temperature sampling.
- .3 Duct mount probe type temperature sensors:
 - .1 provided for ducts of cross section less than 0.4 m² (4 sq. ft),
 - .2 sensor operating temperature range from -40°C to 121°C (-40°F to 250°F),
 - .3 copper or brass or stainless steel sheathed construction,
 - .4 ambient relative humidity: 5 to 95% RH non-condensing,
 - .5 metal mounting plate,
 - .6 probe length such that sensing element is between 35 and 70% of duct width or diameter,
 - .7 provided as multiple sensors where single element cannot be located to provide proper duct or plenum temperature sampling.
- .4 Pipe thermowell-mounted temperature sensors:
 - .1 for measurement of fluid temperatures in piping,
 - .2 insertion elements for measurement of fluid temperatures with stainless steel sheath,
 - .3 sensor operating temperature range: -40°C to 121°C (-40°F to 250°F),
 - .4 spring loaded construction with compression fitting for 20mm (NPS ¾) well mounting,
 - .5 length suitable for application,
 - .6 stainless steel or chrome plated brass thermowells of size and material to suit relevant sensor, pipe and service.
- .5 Outside air temperature sensors:
 - .1 insertion type for through-the-wall installation with stainless steel sheath,
 - .2 sensor operating temperature range: -25°C to 60°C (-13°F to 140°F),
 - .3 waterproof seal at wall,
 - .4 ambient relative humidity: 5 to 95% RH non-condensing,
 - .5 total active probe length: 100 mm to 150 mm (4 in to 6 in),
 - .6 non-corroding outdoor shield to minimize solar heating effect,
 - .7 inert section passing through wall to allow precise measurement of outdoor temperature.

2.5 Temperature Sensors – General Purpose Space Sensors

- .1 For general use space/room temperature measurement.
- .2 General purpose space temperature sensors – no display (type TS):
 - .1 hard-wired sensor only, no display,
 - .2 sensor operating temperature range: 4°C to 60°C (40°F to 140°F),
 - .3 enclosure: surface mounted, blank (no interface) plastic mono-chromatic guard with surface mounting plate and wall anchors,
 - .4 guard secured to mounting plate by screws or snaps.
- .3 Space temperature sensors with display (type TSD):
 - .1 BAS network sensor with user interface display,
 - .2 user interface:

- (a) LCD display, for measured values and setpoint values,
 - (b) temperature display resolution: 0.1°C (0.2°F)
 - (c) physical or virtual buttons for user adjustment of setpoints and selection of measured values.
- .3 Programmable user input selection (buttons):
 - (a) physical or touchscreen buttons,
 - (b) sensor reading selection,
 - (c) sensor setpoint adjustment (temperature only),
- .4 ambient relative humidity: 5 to 95% RH non condensing,
- .5 temperature sensor: 10 kOhm,
- .6 temperature sensor accuracy: $\pm 0.2^{\circ}\text{C}$ ($\pm 0.36^{\circ}\text{F}$)
- .7 adjustable setpoint range (programmed default is 20°C to 25°C (68°F to 78°F)),
- .8 BAS field-bus connector to allow local access to sensor and BAS controller and network,
- .9 temperature setpoint remotely resettable from BAS,
- .10 minimum/maximum limit set point values adjustable locally and remote from BAS,
- .11 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors,
- .12 network connection: BACnet MSTP.
- .13 guard secured to mounting plate by screws or snaps.
- .4 Space temperature sensors with display and additional features (type TSD/x):
 - .1 Type TSD space temperature sensors with the following additional sensor elements, singly and in combination.
 - .2 Relative humidity sensor (type TSD/H)
 - (a) accuracy: $\pm 3\%$ RH of reading,
 - .3 Carbon Dioxide sensor (type TSD/C):
 - (a) dual beam, self-calibrating NDIR detection,
 - (b) range: 0 – 2000 ppm
 - (c) accuracy: ± 50 ppm + 2% of measured value at 25°C (77°F)
 - (d) stability: 20 ppm/year
 - .4 Occupancy sensor (type TSD/O):
 - (a) passive infrared motion sensor,
 - (b) range: 5 m (16 ft) minimum,
 - (c) sweep coverage: 100° horizontal.
- .5 Special purpose space temperature sensors - Secure Areas (type TSS):
 - .1 hard-wired sensor only, no display,
 - .2 sensor operating temperature range: 4°C to 60°C (40°F to 140°F),
 - .3 enclosure:
 - (a) stainless steel flat plate surface type with sensor epoxy-bonded to back of cover plate,
 - (b) secured to standard electrical junction box with Torx head fasteners with center-pin.

2.6 Humidity Sensors – General Purpose

- .1 Sensor construction general requirements:

- .1 measurement operating ranges of 10 to 100% R.H.
- .2 sensor operating temperature range from -40°C to 121°C (-40°F to 250°F)
- .3 solid state sensing element,
- .4 accuracy of $\pm 3\%$ RH reading over range of 5 to 95% R.H.,
- .5 independent, non-interactive span and zero adjustments,
- .6 0-100% linear proportional output signal indicating relative humidity, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
- .7 strain minimizing construction,
- .8 screwed terminal connector block.
- .2 Duct mount probe type humidity sensors:
 - .1 metal mounting plate,
 - .2 constructed with 304 stainless steel element enclosure,
 - .3 length such that sensing element is between 35% and 70% of duct width or diameter from duct wall.
- .3 Outside air type humidity sensors:
 - .1 weatherproof enclosure with cover,
 - .2 waterproof seal.
- .4 Space humidity sensors (not included as part of a space temperature sensor):
 - .1 surface mounted plastic guard with surface mounting plate and wall anchors
 - .2 guard secured to mounting plate by screws,
 - .3 analogue LCD humidity display.

2.7 Duct Type Combination Temperature and Humidity Sensors – General Purpose

- .1 Where both temperature and humidity are shown to be measured at same location or in same airstream, use of single measuring unit is permitted provided that features and performance of both the temperature sensor and the humidity sensor are in accordance with requirements of this specification.

2.8 Pressure Switches

- .1 General:
 - .1 device pressure ratings – water, compressed gases and vapours: not less than the design pressure of the applicable piping system specification.
 - .2 device pressure rating – ventilation ducts: minimum 14 kPa (2 psi).
- .2 Differential pressure switches:
 - .1 spring loaded diaphragm type,
 - .2 suitable for use with air, inert gas, water, glycol, steam,
 - .3 adjustable set-point and differential,
 - .4 snap acting SPDT contacts rated at 120 volts, 15 amps AC or 24 volts DC,
 - .5 switch mounted with diaphragm in vertical plane,
 - .6 automatic in operation and automatically reset when condition returns to normal,
 - .7 operating temperature range: 0°C to 60°C (35°F to 140°F),

- .8 operating humidity: 10 to 90% RH non-condensing,
- .9 high and low pressure ports, brass hose barbed pressure fittings suitable for Ø8 mm (¼ in) tubing,
- .10 mounting bracket suitable for duct mounting,
- .11 dust proof enclosure,
- .12 screw terminal block.
- .3 Pressure switches:
 - .1 bourdon tube, bellows or diaphragm type,
 - .2 suitable for use with air, inert gas, water, glycol, steam, ammonia or non-corrosive refrigerants,
 - .3 selected with span of not greater than twice maximum set pressure,
 - .4 adjustable set-point,
 - .5 snap acting SPDT contacts rated at 120 volts, 15 amps AC or 24 volts DC,
 - .6 automatic in operation and automatically reset when condition returns to normal,
 - .7 dust proof enclosure,
 - .8 screw terminal block.

2.9 Pressure Sensors/Transmitters

- .1 General:
 - .1 device pressure ratings – water, compressed gases and vapours: not less than the design pressure of the applicable piping system specification.
 - .2 device pressure rating – ventilation ducts: minimum 14 kPa (2 psi).
- .2 Duct static pressure sensors:
 - .1 for static and differential static pressure measurement of duct airflow,
 - .2 type: diaphragm driven, capacitance change type, 0-100% linear proportional output signal indicating static pressure or differential pressure at station,
 - .3 selected with span of not greater than twice the maximum static pressure and not less than twice differential pressure at shut-off.
 - .4 output: 4-20 mA, 0-5 Vdc or 0-10 VDC,
 - .5 power supply: 24 VAC/VDC,
 - .6 stainless steel duct probe, with length equal to between 35% and 70% of duct width or diameter,
- .3 Piping static pressure and differential pressure sensors:
 - .1 for static and differential static pressure measurement for liquids, gases and vapours,
 - .2 type: diaphragm driven, capacitance change type, 0-100% linear proportional output signal indicating static pressure or differential pressure at station,
 - .3 stainless steel wetted parts,
 - .4 output: 4-20 mA, 0-5 Vdc or 0-10 VDC,
 - .5 power supply: 24 VAC/VDC,
- .4 Piping static pressure and differential pressure transmitters:
 - .1 for static and differential static pressure measurement for liquids, gases and vapours,
 - .2 type:
 - (a) type 316L stainless steel diaphragm driven, capacitance change type,

- (b) signal conditioning electronics for 0-100% linear proportional output signal,
- .3 operator interface: LCD display of measured process value, with selectable units.
- .4 wetted parts: type 316L stainless steel,
- .5 process connections:
 - (a) type 316L stainless steel threaded fitting,
 - (b) NPT to ASME B1.20.1,
- .6 output: 4-20 mA
- .7 field adjustable zero and span,
- .8 selected with span of not greater than twice maximum static pressure and not less than twice differential pressure at shut-off.
- .9 accuracy, including non-linearity, hysteresis and non-repeatability: $\pm 0.05\%$ full scale,
- .10 operating temperature range; -40°C to 80°C (-40°F to 185°F),
- .11 operating humidity range; 0 to 100% relative humidity,
- .12 mounting bracket, suitable for pipe mounting,
- .13 enclosure;
 - (a) cast aluminum,
 - (b) Type 4X to CSA C22.2 No. 94.1 or NEMA,
 - (c) polyurethane finish paint,
 - (d) screw terminal connector block.
- .5 Differential pressure transmitters for terminal units:
 - .1 suitable for use in air with pressure independent terminal units (constant volume, variable volume or fan powered),
 - .2 capacitive sensor technology,
 - .3 pressure range: 0 to 373 Pa (0 to 15 in.w.g.),
 - .4 linear output proportional to velocity pressure of unit inlet air stream, and suitable as analog input to terminal unit controller,
 - .5 accuracy including non-linearity, hysteresis, and non-repeatability: $\pm 1\%$ full scale
 - .6 operating temperature range: 0°C to 50°C (32°F to 122°F)
 - .7 operating humidity range: 10 to 90% non-condensing
 - .8 high and low pressure ports, barbed pressure fittings suitable for $\varnothing 8$ mm ($\frac{1}{4}$ in) tubing for connection to air flow pick up device provided with terminal box,
 - .9 mounting kit, suitable for installation within terminal unit controller enclosure,
 - .10 coded screw terminals .

2.10 Occupancy Sensors

- .1 Passive infrared sensor with temperature compensated pyro-electric dual active element,
 - .1 ceiling or wall mounted,
 - .2 LED indication light(s),
 - .3 digital time delay adjustable: from 30 seconds to 30 minutes,
 - .4 area coverage: 200 m^2 (2000 ft^2),

- .5 output: SPDT isolated output relay, rated for 1 A at 24 VDC/VAC,
- .6 power supply: 24 VDC,
- .7 with 120 VAC/24 VDC transformer power supply unit.

Standard of Acceptance

- Watt Stopper Model CX-100

2.11 Air Flow Measuring Devices

- .1 Multiple head pitot tube type stations:
 - .1 diamond shape cross-section averaging Pitot tube-style sensor with multiple tube structure, averaging chambers and bidirectional flow sensing capability,
 - .2 sheet metal duct collars,
 - .3 selected for operating flow range, duct size and air temperature,
 - .4 integral differential pressure sensor with analog output signal proportional to differential pressure across sensor, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - .5 accuracy: $\pm 1\%$ of actual value,
 - .6 repeatability: $\pm 0.1\%$ of actual value,
 - .7 flow turndown: greater than 10:1,
 - .8 differential pressure range: 0 to 1250 Pa (0 to 5 in wg),
 - .9 operating pressure: up to 34.3 kPa (5 psig),
 - .10 operating temperature rating: -4°C to 95°C (-20°F to 200°F),
 - .11 operating pressure rating: 1725 kPa (250 psig)
- .2 Thermal anemometer probe type airflow measuring stations:
 - .1 sensors mounted in sheet metal duct collars of aluminum or stainless steel,
 - .2 each thermistor mounted in solid thermoplastic housing,
 - .3 probe length equal to greater of two inside dimensions of rectangular and oval ducts and equal to duct diameter for round ducts,
 - .4 minimum two sensing points per probe,
 - .5 independent averaging of multiple sensing points,
 - .6 averaging amplifier with adjustable offset and span for multiple probe applications,
 - .7 temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - .8 velocity accuracy: $\pm 2\%$ of reading,
 - .9 temperature accuracy: 0.10°C (0.18°F),
 - .10 resolution: 0.4% of scale,
 - .11 repeatability: $\pm 0.2\%$ of reading,
 - .12 velocity range; 0 to 25m/s (0 to 5000 fpm),
 - .13 maximum allowable pressure drop: 1.2 Pa at 10m/s (0.005 in wg at 2000 fpm),
 - .14 flow station operating temperature range: 0°C to 70°C (30°F to 160°F) -29°C to 71°C (-20°F to 160°F),
 - .15 electronics operating temperature range: 0°C to 70°C (30°F to 160°F),

- .16 flow station operating humidity range: 0 to 99% RH non-condensing,
- .17 dedicated electronic, solid state digital processing control panel with general purpose NEMA 2 enclosure,
- .18 provided with upstream and/or downstream flow conditioning.
- .3 Thermal anemometer type airflow measuring stations for installation at fan inlets:
 - .1 fan inlet bell mouth mounted with adjustable steel strut and mounting feet,
 - .2 minimum of two flow sensing thermistors and temperature sensors per station, two stations for DWDI fans,
 - .3 sensors mounted in aluminum casing and recessed within strut,
 - .4 independent averaging of multiple sensing points,
 - .5 temperature compensated linear analog output signal indicating average velocity at station, 4-20 mA, 0-5 Vdc or 0-10 Vdc,
 - .6 velocity accuracy: $\pm 2\%$ of reading,
 - .7 temperature accuracy: $\pm 0.2^{\circ}\text{C}$ (0.36°F),
 - .8 resolution: 0.4% of scale,
 - .9 repeatability: $\pm 0.2\%$ of reading,
 - .10 velocity range: 0 to 25m/s (0 to 5000 fpm),
 - .11 maximum allowable pressure drop: 1.2 Pa at 10m/s (0.005 in.w.c. at 2000 fpm),
 - .12 flow station operating temperature range: 0°C to 71°C (30°F to 160°F),
 - .13 electronic operating temperature range: 0°C to 71°C (30°F to 160°F),
 - .14 flow station operating humidity range: 0 to 99% RH non-condensing,
 - .15 dedicated electronic, solid state digital processing control panel with general purpose dustproof enclosure.
- .4 Provide mounting hardware for installation of airflow measuring stations by sheet metal contractor.

2.12 Air Flow Switches

- .1 For indication of air flow within duct.
- .2 Differential pressure activated, diaphragm type,
 - .1 snap-action SPDT switch, 10 A @ 120 VAC,
 - .2 field adjustable set point,
 - .3 minimum air velocity: 1 m/s (200 fpm),
 - .4 maximum air velocity: 10.2 m/s (2000 fpm),
 - .5 operating ambient temperature range: 0°C to 40°C (32°F to 104°F),
 - .6 dustproof enclosure with mounting plate and gasket seal.

2.13 Liquid Flow Switches

- .1 For indication of fluid flow in piping systems.
- .2 Suitable for use with water, ethylene or propylene glycol, chlorinated or treated water
 - .1 snap-action SPDT switch, 10 A @ 120 VAC,
 - .2 operating ambient temperature range: 0°C to 82°C (32°F to 180°F) -34°C to 82°C (-30°F to 180°F)

- .3 operating liquid temperature range: 0°C to 121°C (32°F to 250°F) -29°C to 121°C (-29°F to 250°F)
- .4 general purpose dust proof enclosure for use indoors with fluids at temperature greater than 0°C (32°F)
- .5 NEMA 3R vapour tight enclosure for use indoors or outdoors with fluids at temperatures below 0°C (32°F).

2.14 Electric Power Instrumentation

- .1 Current sensing relays:
 - .1 metering transformer ranged to match load being metered,
 - .2 plug in base and shorting shunt to protect current transformer when relay is removed from socket,
 - .3 current transformer for single or three phase metering connected into single relay,
 - .4 adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level,
 - .5 discrimination between phases in three phase applications to allow worst case selection,
 - .6 mounted in motor starter enclosure and fed from starter control transformer,
 - .7 relay contacts capable of handling 10 amps at 240 volts.
- .2 Current Switches:
 - .1 self-powered, solid-state type with adjustable trip current,
 - .2 integral current transformers and relays to indicate motor status,
 - .3 SPDT output relay suitable for use as digital input to the BAS,
 - .4 field adjustable output relay trip setting, over 0-100% of range. Deadband adjustment to maximum of 10% of range,
 - .5 integral zero-leakage LED's indicating sensor power and switch status,
 - .6 long term setting drift of current transformer and relay combination not more than 5% full range over 6 months,
 - .7 over current and over voltage protection for current transformer and relay,
 - .8 operating temperature range; -10°C to 50°C (14°F to 122°F),
 - .9 operating humidity range; 5% to 90% RH non condensing.
- .3 Current transducer:
 - .1 output signal proportional to measured line current,
 - .2 output signal in one of following ranges; 4-20 mA, 0-5 Vdc or 0-10 Vdc
- .4 AC Current Transmitters:
 - .1 self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output,
 - .2 full-scale unit ranges of 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment,
 - .3 accuracy: $\pm 1\%$ full-scale at 500 ohm maximum burden.
 - .4 UL/CSA listed and meet or exceed ANSI/ISSA 50.1 requirements.
- .5 AC Voltage Transmitters:
 - .1 self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
 - .2 adjustable full-scale unit ranges; 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac.

- .3 Accuracy: $\pm 1\%$ full-scale at 500 ohm maximum burden.
- .4 UL/CSA listed, 600 Vac rated and conforming to ANSI/ISSA 50.1.
- .6 Power Monitors:
 - .1 three-phase type with three-phase disconnect and shorting switch assembly,
 - .2 UL listed voltage transformers, and
 - .3 UL listed split-core current transformers.
 - .4 selectable output either rate pulse for kWh reading or 4-20 mA for kW reading.
 - .5 maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.

3 EXECUTION

3.1 Instrumentation Installation – General Requirements

- .1 Mount instrumentation;
 - .1 in clean areas wherever possible,
 - .2 to be accessible to allow for replacement and servicing without interfering with access for adjacent equipment and personnel traffic in surrounding space,
- .2 Provide access doors where instrumentation is concealed behind solid surfaces.
- .3 In finished spaces and rooms, install room instrumentation on concealed junction boxes;
 - .1 fully recessed in gypsum board, wood, or similar construction,
 - .2 fully recessed in new concrete block construction, with conduit run block void spaces,
 - .3 fully recessed in new poured concrete construction, with conduit and outlet box roughed-in before concrete pour.
 - .4 surface mounted with exposed conduit on existing concrete block walls and existing poured concrete walls.
- .4 In service rooms, loading docks, and parking garages, install room instrumentation on surface mounted junction boxes with exposed surface-mounted conduit.
- .5 Rigidly support field mounted instrumentation on pipe stands or channel brackets.
- .6 Rigidly support duct mounted instrumentation to side of duct, in a location that will allow full removal of the instrumentation including duct probes.
- .7 Orient instrumentation sensing elements to correctly sense measured variable and to be isolated from vibrations and environmental conditions that could affect measurement or calibration.
- .8 Identify each cable and wire at every termination point.
- .9 Air seal wires attached to sensors at entry into junction box.

3.2 Power and Control Wiring

- .1 Provide power and control wiring to each instrument in accordance with the manufacturer requirements and in accordance with specification section 25 05 13.

3.3 Temperature and Humidity Instrumentation

- .1 Averaging duct temperature sensors:
 - .1 Use averaging sensors in the following locations:
 - (a) mixing plenums in front of the first downstream component,

- (b) ducts with cross sectional area greater than 1.5 m² (16 sq. ft),
- (c) downstream of the supply air leaving side of a thermal heat wheel, located approximately 200 mm (8 in) from leaving face of wheel.
- .2 Install averaging sensors in serpentine manner vertically across duct. Support each bend with capillary clip. Provide sensor element length of 3 m per m² (1 ft per ft²) of plenum/duct cross sectional area.
- .2 Low-temperature switch:
 - .1 Install mixing plenum low-limit temperature switches in serpentine manner horizontally across duct. Support each bend with capillary clip. Provide sensor element length of 3 m per 1 m² (1 ft per 1 sq. ft) of coil area.
- .3 Pipe mounted temperature sensors:
 - .1 Thermowells to be installed by the trade contractor under the applicable Division of the Work for each piping system. Supply the thermowells to the trade contractor and coordinate with them as to installation location and orientation.
 - .2 For existing steel piping systems, coordinate with the piping trade contractor to install the thermowells by hot-tapping in accordance with specification section 20 05 26 except where the Owner permits draining of the piping system.
 - .3 Install pipe-mounted liquid temperature sensors in thermowells with heat-conducting material.
 - .4 Orientate thermowells and transmitters to be located from the side of the pipe or top of pipe for horizontal piping.
 - .5 Cut and recover piping insulation to 300 mm (12 in) either side for installation of strap-on temperature sensors. Provide removable insulation box over sensor and patch insulation to match existing.
- .4 Space temperature and humidity sensors:
 - .1 Mount space temperature or combination temperature/humidity sensors / transmitters at 1200 mm (4 ft) above finished floor.
- .5 Humidity sensors:
 - .1 Locate humidity sensors adjacent to temperature sensors except as follows.
 - .2 Locate humidity sensors in the supply air downstream of a thermal heat wheel in a location that represents the average relative humidity when hand-measured at the upstream face of the next component in the air handling unit.
- .6 Outdoor temperature and humidity transmitters:
 - .1 Install outdoor air combination humidity and temperature transmitters on north facing wall, in a location readily accessible for maintenance access.

3.4 Space Temperature Sensor Selection

- .1 Select general purpose space temperature sensor types in accordance with the following table unless otherwise shown on drawings or in control sequences:

Space Types	Temperature Sensor Type
Private offices	TSD/O
Open plan offices	TSD

Meeting rooms, class rooms, private dining rooms, faith congregation spaces, gymnasias	TSD/C/O
Public dining areas, libraries, art galleries	TSD TSD/C
Service rooms, corridors, data centers, distributed electrical and data rooms, janitorial rooms, loading docks, storage rooms	TS
Building entrances, lobbies, elevator lobbies, stairwells	TS
Kitchens, laundry rooms	TS TSD
Maintenance workshops	TS
Non-specific process spaces	TS
Healthcare operating rooms	TSD/H
Healthcare treatment rooms and procedure rooms	TSD TSD/O
Laboratories	TSD TSD/O
Mental health patient rooms, secure rooms	TSS
All other spaces not identified above	TS TSD

3.5 Differential Air Static Pressure Sensors

- .1 Install duct static pressure sensors rigidly to side of duct to ensure duct probe is at 90° to the direction of airflow.
- .2 Supply duct static pressure;
 - .1 pipe high-pressure tap to duct using pitot tube,
 - .2 make pressure tap connections according to manufacturer's recommendations.
- .3 Return duct static pressure;
 - .1 pipe high-pressure tap to duct using pitot tube,
 - .2 make pressure tap connections according to manufacturer's recommendations.
- .4 Building static pressure;
 - .1 pipe pressure sensor's low-pressure port to static pressure port located on outside of building through high-volume accumulator,
 - .2 pipe high-pressure port to location behind thermostat cover.
- .5 Piping to air pressure transducer pressure taps to contain capped test port adjacent to transducer.
- .6 Install duct differential pressure sensors across fans, filters and other devices as shown.
- .7 Trim impulse lines to use the shortest length while maintaining adequate bending radius without kinking impulse tubes.
- .8 Locate air pressure transducers, except those controlling terminal unit boxes;
 - .1 in control panels, not on monitored equipment or on ductwork,
 - .2 mount transducers in vibration-free location accessible for service without use of ladders or special equipment.

3.6 Airflow Measuring Stations

- .1 Provide transducers, relays, and interconnection wiring to perform Sequences of Operations as detailed and Monitoring in accordance with Controls Schematics.

3.7 Fluid Pressure Switch

- .1 Mount pressure switch tees adjacent to fluid pressure gauge taps. Install shut-off valves before tee for water gauges.
- .2 Install pressure snubbers on pressure switches at;
 - .1 suction and discharge sides of oil pumps, and positive displacement pumps,
 - .2 for compressed air at compressors, dryers and receivers.
- .3 Install coil syphons on steam and condensate pressure switches.

3.8 Fluid Pressure Sensors and Transmitters

- .1 Provide isolation valve and snubber between pressure sensor/transmitter and pressure source.
- .2 Install coil syphons on steam and condensate pressure sensors/transmitters.
- .3 Provide two pressure transducers with software calculation at controller for differential pressure measurements in fluid piping systems.

3.9 Flow Switch Installation

- .1 Fit correct length paddle for diameter of pipe.
- .2 Adjust switch for specified flow condition in accordance with manufacturer's instructions

3.10 Occupancy Sensors

- .1 Install occupancy sensors in ceiling as shown.

3.11 Safety Controls

- .1 Unless otherwise shown, safety devices including smoke detectors, freezestats, low- and high-pressure cut-offs, and other safety switches and controls, are to be hard-wired to de-energize equipment as described in Sequence of Operation.
- .2 Provide contacts that allow BAS software to monitor safety control status.

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

BUILDING AUTOMATION CONTROL VALVES

25 30 19.13

1 GENERAL

1.1 Scope

- .1 Provide automatic control valves.
- .2 Provide valve actuators in accordance with specification section 25 30 13.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 25 30 13 Building Automation Actuators and Operators

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B51 Boilers, Pressure Vessels, and Pressure Piping Code.
- .2 Product standards:
 - .1 ASME B1.20.1 Pipe Threads, General Purpose, Inch
 - .2 ASME B16.5 Pipe Flanges and Flanged Fittings
 - .3 CSA B242 Groove and Shoulder Type Mechanical Pipe Couplings

1.4 Design Criteria

- .1 Refer to applicable piping specification sections for piping system design pressure and design temperature.

1.5 Quality Control

- .1 Valves to have current Canadian Registration Numbers in accordance with CSA B51.

1.6 Submittals

- .1 Shop drawings:
 - .1 submit product data sheets for materials specified herein,
 - .2 submit a schedule of control valves, identifying at a minimum the control valve tag, flow rate, pressure drop, Kv (Cv) values, valve body type, valve body pressure rating at design temperature, and CRN number.

2 PRODUCTS

2.1 Control Valves General Requirements

- .1 Body and trim materials selected in accordance with specification for globe valves, ball valves, or high performance butterfly valves in applicable piping system valve specifications, and in accordance with manufacturer's recommendations for design conditions and service.
- .2 Control valve type selections are shown on drawings, schematics and schedules.
- .3 Pipe end connections:

- .1 NPS ½ to NPS 2: NPT to ASME B1.20.1.
- .2 NPS 2-1/2 and larger: flanged to ASME B16.5, or grooved to CSA

2.2 Water and Glycol Valves – Two Position, Two- and Three-Way

- .1 Valves for two-position service
 - .1 ON-OFF for two-way valve,
 - .2 Open port A - Open port B for three-way valve (non-isolation of ports simultaneously).
- .2 Valve pattern:
 - .1 two-way: straight through type, single seated, with replaceable ball, seats and/or disc.
 - .2 three-way: dual seated for globe valves, three way flow pattern for ball valves,
- .3 Valve size: pipeline size.
- .4 Valve type selection:
 - .1 full port ball valves, sizes NPS 2 and smaller,
 - .2 butterfly valves, sizes NPS 2 and larger.
- .5 Valve flow characteristic:
 - .1 quick opening or linear flow characteristics.

2.3 Water and Glycol Valves – Modulating Two-Way

- .1 Valves for two-way modulating service.
- .2 Valve pattern: straight through two port type, single seated, with replaceable disc or ball.
- .3 Valve type:
 - .1 globe valves for all flow rates.
 - .2 characterized ball valves for flow coefficient $K_v = 35$ ($C_v = 40$) and smaller,
 - .3 butterfly valves for flow coefficient greater than $K_v = 35$ ($C_v = 40$), based on flow coefficient rating at 70° rotation
- .4 Valve size:
 - .1 size valves based on design flow rates at a pressure drop not greater than the design pressure drop as shown, and not less than 90% of that design pressure drop.
 - .2 where valve pressure drops are not shown, size valve pressure drop (at design flow) to be the greatest of;
 - (a) 200% of pressure drop through heat exchanger,
 - (b) 100% of pressure drop through coil, or
 - (c) 35 kPa (5 psi).
 - .3 for terminal box units and duct mounted reheat coils, size valves on a pressure drop of between 20 to 35 kPa (3 to 5 psi).
- .5 Valve flow characteristic:
 - .1 equal percentage flow characteristics for heat transfer coils and heat exchangers,
 - .2 linear flow characteristic for tank filling operation (water flow discharges to atmosphere).

2.4 Water and Glycol Valves – Modulating Three-Way

- .1 Valves for three-way modulating mixing/diverting service:
- .2 Valve pattern: three-way type with dual seated for globe valves, three way flow pattern for ball valves,
- .3 Valve type:
 - .1 globe valves for all flow rates,
 - .2 characterized ball valves for flow coefficient $K_v = 35$ ($C_v = 40$) and smaller,
- .4 Valve size:
 - .1 unless otherwise shown, size valve pressure drop (at design flow) to be the smaller of;
 - (a) twice the pressure drop through coil or heat exchanger, or
 - (b) 35 kPa (5 psi).
- .5 Valve flow characteristic:
 - .1 linear flow characteristic for each port to give constant total flow, or,
 - .2 equal percentage flow characteristics with 25% valve authority (valve pressure drop equal to 33% pressure drop through load at full flow).

2.5 Water and Glycol Valve Actuators

- .1 Conform to section 25 30 01 and as specified herein.
- .2 Actuator and valve trim selected for close-off pressure ratings:
 - .1 two-way modulating or two position service: 150% of pump shut off head.
 - .2 three-way modulating service; 300% of pressure differential between ports A and B at design flow or 100% of pump shut off head.
 - .3 shut off head to be based on maximum pump RPM when pump is controlled with a VFD.
- .3 Valve failed position on isolation from control signal:
 - .1 spring-return or electronically fail safe,
 - .2 heating terminal/zone valves: normally open,
 - .3 heating coil valves in AHU; normally open,
 - .4 heating differential pressure by-pass control valves; normally closed,
 - .5 chilled water terminal, zone and AHU coil valves; normally closed,
 - .6 chilled water valves serving process loads: normally open,
 - .7 chilled water differential pressure by-pass control valves: normally open,

2.6 Steam Valves

- .1 Valves for two-way modulating service.
- .2 Valve pattern: straight through two port type, single seated, with replaceable disc or ball.
- .3 Valve type: globe.
- .4 Valve size:
 - .1 two-position service;
 - (a) pressure drop at design flow equal to 10%-20% of inlet steam gauge pressure.
 - .2 modulating service at inlet steam gauge pressure of 100 kPa (15 psig) or less;
 - (a) pressure drop at design flow equal to 80% of inlet steam gauge pressure.

- .3 modulating service at inlet steam gauge pressure of 101-350 kPa (16-50 psig);
 - (a) pressure drop at design flow equal to critical pressure drop (45% of absolute inlet pressure).
- .4 modulating service with inlet steam gauge pressure over 350 kPa (50 psig);
 - (a) pressure drop as shown.
- .5 modulating steam loads greater than 570 kW (2000 lbs/hr) at all pressures;
 - (a) provide two valves, connected in parallel and controlled in sequence, with first valve in opening sequence sized for 1/3 and second for 2/3 of steam load.
- .5 Valve flow characteristic:
 - .1 equal percentage flow characteristics.
- .6 Actuator and trim:
 - .1 conform to section 25 30 01 and as specified herein.
 - .2 selected for close-off pressure rating equal to 150% of operating (inlet) pressure.

3 EXECUTION

3.1 General

- .1 Select control valves for the applicable flow rates and pressure drops.

3.2 Installation

- .1 Supply control valves to the applicable trades contractor for installation. Provide instruction to the trades contractor as to:
 - .1 any required straight pipe lengths upstream and downstream of the valve,
 - .2 correct installation orientation including requirements for valve actuator,
 - .3 for steam systems, location of steam trap drips ahead of the valve on horizontal piping.

3.3 Cleaning

- .1 Coordinate with the applicable installation trades contractor to provide protection of the control valve during pipeline cleaning. Ensure control valves are 100% open during pipeline cleaning.
- .2 After completion of pipeline cleaning, clean strainers located ahead of control valves.

3.4 Start-Up and Testing

- .1 Confirm control valves stroke fully open and fully closed under applied control signal.
- .2 Conduct tests at part load < 30% to check for control loop instability; adjust control parameters to eliminate valve hunting under steady part load conditions.
- .3 While maintaining constant system differential pressure at coil branch piping, test coil power output vs valve position, at equipment part load conditions between 10% and 100% design load, at 10% load increments. Provide a test report for each applicable coil, including a graph depicting valve position vs coil power output.

End of Section

BUILDING AUTOMATION CONTROL DAMPERS

25 30 23.13

1 GENERAL

1.1 Scope

- .1 Provide ductwork control dampers for building systems automation.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 23 33 13.13 Dampers - Operating
 - .2 25 30 13 Building Automation Actuators and Operators

1.3 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 Motorized Control Dampers

- .1 Construction:
 - .1 conform with section 23 33 13.13.
- .2 Actuators:
 - .1 conform with section 25 30 13.

3 EXECUTION

3.1 Coordination

- .1 Coordinate with the trade contractor under Division 23 to confirm control damper quantity, sizes, blade orientation, actuator position, and damper linkage.

Supply control dampers to the trade contractor under Division 23 for installation by that trade.

3.2 Selection

- .1 Select control damper type (parallel blade, opposed blade) in accordance with section 23 33 14.

End of Section

THIS PAGE INTENTIONALLY LEFT BLANK

BUILDING AUTOMATION CONTROL SEQUENCES

25 90 01

1 GENERAL

1.1 Scope

- .1 This section describes the control sequences and monitoring requirements for building services and other facility equipment or services.

1.2 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ASHRAE 36 High Performance Sequences of Operation for HVAC Systems

1.3 Definitions

- .1 The following definitions apply to this section:
 - .1 **Auto (alarm reset):** an alarm that automatically resets once the exit hysteresis conditions have been met.
 - .2 **Exit hysteresis:** the conditions which must be met before an alarm can be reset or cleared.
 - .3 **Latch (alarm reset):** an alarm that must be manually reset by the Operator through the BAS, even if the exit hysteresis conditions have been met.
 - .4 **Post-exit suppression:** the time duration after an alarm has been reset/cleared before the same alarm (in the same system) can be annunciated by the BAS.
- .2 The following group headings are used in the control sequences:
 - .1 **Reference:** the drawing which includes the control schematic.
 - .2 **Applicable System:** the systems for which the control sequence applies; may include multiple instances of the equipment or system.
 - .3 **General:** (if included) general background information concerning the system.
 - .4 **OEM Control:** (if included) a general description of control functions included in equipment OEM control panel – provided to clarify control functionality that is not directly controlled by the BAS.
 - .5 **System Start:** actions required at system start-up under schedule control or on re-start after power failure.
 - .6 **Normal Operation:** normal control sequence after initial start-up requirements are satisfied.
 - .7 **System Overrides:** control functions that automatically, or by user input, disable or change the control sequence for a defined period of time.
 - .8 **Unoccupied Mode Override:** a user input command to enable a control system during times when the system is disabled by an operating schedule.
 - .9 **Demand Limiting:** special operation parameters during normal utility power outages (emergency generator operation)
 - .10 **System Stop:** shut-down of system under schedule control and fail-safe position of system in event of loss of normal power.
 - .11 **Integrated FPLS Function:** control functions which are integrated with other fire protection and/or life safety systems.
 - (a) **Fire Alarm:** action required in the event of a signal from the fire alarm system (FA).
 - (b) **Smoke Control:** action required where the system functions as part of a smoke control or smoke venting system.

- .12 **Network Integration:** control points (hardware or software) which are communicated over a serial network.
- .13 **Monitoring:** control point data which is collected and included in graphical displays but are not used as part of a control loop.
- .14 **Schedule:** scheduled operation of system.
- .15 **Alarm:** alarm points required.
 - (a) **Level 1:** alarms which affect life safety,
 - (b) **Level 2:** alarms which affect critical equipment,
 - (c) **Level 3:** alarms which require urgent notification to the operator, and which affect non-critical equipment,
 - (d) **Level 4:** alarms which are non-urgent, affect non-critical components, and generally relate to pending maintenance.
- .16 **Control Power Type:** control system elements to be fed from the designated source of power.

2 PRODUCTS

- .1 Not applicable.

3 EXECUTION

3.1 Sequence of Operation and Control Drawings

- .1 Control sequences for HVAC systems are to conform to ASHREA 36. Requirements prescribed herein may summarize selected elements of ASHRAE 36 for convenience, but such requirements do not limit or restrict the application of that standard except as otherwise specified herein.
- .2 Control sequences that follow describe and detail method of control of systems.
- .3 Control drawings listed for each control sequence illustrate required inputs and outputs for the control and monitoring of systems.
- .4 Review sequence of operation described for each system and allow for additional input and output points to achieve method of control described. Review documents to determine quantity of each piece of equipment or system.

3.2 Rebooting of BAS Controllers on Resumption of Power

- .1 Except where a BAS controller is supported on UPS power, upon resumption of power to a BAS controller after a power interruption program each controller so that;
 - .1 once the controller has rebooted, wait 30 seconds before attempting to automatically restart the associated equipment except as follows:
 - (a) cooling towers not equipped with VFDs: 60 second time delay,
 - (b) centrifugal chillers: 120 second time delay,
 - (c) heating and steam boilers: 120 second time delay.
 - .2 the controlled equipment restarts from a System Start condition.

3.3 Restart of Major Equipment on Return to Utility Power Supply

- .1 Where a BAS controller and associated controlled equipment are supported on site-generated power, use a "pre-transfer to utility" signal from the site-generated power control system to cause the following equipment to shut-down (but associated pumps may continue to operate) before transfer to utility power is implemented:

- .1 refrigeration equipment,
- .2 heating boilers,
- .3 steam boilers.

3.4 VFD Minimum Speed Setpoints

- .1 The BAS is to maintain a software setpoint for each VFD based on the requirements for each sequence of operation. Every 60 minutes, the BAS is to read the VFD's internal minimum speed setpoint. If a mismatch exists between the VFD internal minimum speed setpoint and the BAS software setpoint, the BAS is to overwrite the VFD internal setpoint via network integration.

3.5 VFD Power Failure Configuration

- .1 Unless otherwise specified in a control sequence, program VFD's for flying restart after restoration of power following a power failure event.
- .2 Where a VFD includes a kinetic recovery function, program the VFD for kinetic recovery to keep the VFD controller DC voltage bus energized by using momentum of driven equipment during a short term power interruption of the mains AC bus.

3.6 VFD Trip Resets

- .1 Unless otherwise specified in a control sequence, the BAS is automatically attempt not more than three reset attempts. If the VFD trips after the 3rd restart attempt, the VFD is to be disabled and an alarm notification sent to the operator of the original trip event(s) and restart attempts.
 - .1 Exception: does not apply to overcurrent or overload trips (if uniquely alarmed).
- .2 Where the same VFD trip condition occurs more than two times in any sliding 60 minute window, an alarm notification is to be sent to the operator of the recurring trip event.

3.7 Operator Adjustable Setpoints

- .1 Where setpoint values are indicated in square brackets [] this means the setpoint is adjustable by the facility operator with appropriate security access rights.

3.8 Power Supply to Controls

- .1 Provide the type of power supply to the applicable controller as shown in the control sequence.

3.9 Alarm Management

- .1 Unless otherwise shown in a control sequence,
 - .1 Level 1 and Level 2 alarms are Latch reset,
 - .2 Level 3 and Level 4 alarms are Auto reset.
- .2 Alarm exit hysteresis conditions are as shown for each alarm:
 - .1 for analog inputs alarms, the conditions are listed in the format "X% / Y time";
 - (a) X%: the percent change of alarm setpoint value in the direction of the normal condition value,
 - (b) Y time: the time duration in seconds or minutes in which the percent change value must exist before the reset can occur.
 - .2 for discrete input alarms for measurement instruments, the conditions are listed in the format " Δ X / Y time";
 - (a) Δ X: the absolute change in SP units of the alarm setpoint value in the direction of normal condition values,

- (b) Y time: the time duration in seconds or minutes in which the percent change value must exist before the reset can occur.
- .3 for discrete input alarms for equipment status, the conditions are listed in the format "COS/ Y time":
 - (a) COS: change of state
 - (b) Y time: the time duration in seconds or minutes in which the percent change value must exist before the reset can occur.
- .3 Post-exit suppression times:
 - .1 Unless otherwise shown, suppress the recurrence of the same alarm after exiting from the previous alarm state:
 - (a) Level 1 – Life Safety: 0 minutes,
 - (b) Level 2 – Critical Equipment: 5 minutes,
 - (c) Level 3 – Urgent Message: 1 hour,
 - (d) Level 4 – Normal Message: 1 day.
- .4 Suppression of contingent alarms:
 - .1 Program an automatic hierarchical suppression scheme, to suppress alarm notifications of a fault alarm condition at a load component, which is contingent (caused by) a the impact of a related fault alarm condition at a source component that serves the load
 - .2 Exceptions: alarms at load components are not suppressed where:
 - (a) a fault alarm at a source component in a redundant component arrangement does not affect the ability of the source system from supplying resources to the load component.
 - .3 Alarm suppression applies to audible and visual alarm notifications to Operator interfaces, including email notifications. Load alarms are still to be registered in the alarm database.
- .5 Suppression of time-based alarms:
 - .1 Program an automatic suppression of alarms using time delays following a change in setpoint as follows:
 - (a) for thermal zone temperature alarms: 18 minutes per 1°C change, but not to exceed 120 minutes.
 - (b) for thermal zone temperature cooling requests: 9 minutes per 1°C change, but not to exceed 30 minutes.
 - (c) for thermal zone temperature heating requests: 9 minutes per 1°C change, but not to exceed 30 minutes.
- .6 Suppression of alarms due to change in operating modes:
 - .1 Suppress alarms for 15 minutes as a result of change of setpoint.
 - .2 Unless otherwise shown, suppress alarms when a system is in Unoccupied mode, Warmup mode, or Cooldown mode.

3.10 Schedules

- .1 The following schedules form part of this specification.
 - .1 Schedule A: List of Control Sequences of Operation

Schedule A: Control Sequences of Operation		
Control Sequence Number	Title	Revision Date
CS-101	SIMPLEX EXHAUST FAN – CONSTANT SPEED	
CS-102	TERMINAL VAV BOX & PERIMETER HEATING	
CS-103	FAN COIL	
CS-104	MENTAL HEALTH DOMESTIC WATER CONTROL	

CS101 – SIMPLEX EXHAUST FAN – CONSTANT SPEED

Reference:

Applicable

System: EF-1, EF-2, EF-3

System

Start: System start is initiated by operator command at BAS or through schedule.

Upon signal to start exhaust fan, Exhaust Air Damper (D1) opens. Open position limit switch hard-wired to exhaust fan starter enables exhaust fan to start when damper is fully open. Exhaust fan starts through hard-wired interlock with limit switch in fan starter.

Normal

Operation: Exhaust fan runs continuously.

System

Stop: System stop is initiated by operator command at BAS or through schedule.

Upon signal to stop exhaust fan, Exhaust Air Damper (D1) closes. Exhaust fan stops through hard-wired interlock with limit switch in fan starter.

Fire Alarm: Exhaust fan continues normal operation during fire alarm.

Schedule: 24/7

Alarm: EST1 Exhaust Fan Status from current sensor

Emergency

Power:

CS102 – TERMINAL VAV BOX & PERIMETER HEATING

Reference:

Applicable

Systems: Existing VAV (typical) in spaces that also have perimeter heating.

System

Start: Boxes are enabled when associated AHU system is operating.

Normal

Operation: **Heating Season**

Space Temperature sensor modulates perimeter heating valve V1 to maintain space temperature setpoint.

Cooling Season

Perimeter heating valve V1 is disabled and closed. Space Temperature (T1) sensor modulates VAV and fan coil (if applicable) to maintain temperature.

Space Temperature Control

Space temperature setpoint (adjustable) are as follows:

< Summer: 24°C ± 2°C

< Winter: 22°C ± 2°C

Air flow (velocity pressure) sensor F1 modulates supply air damper to maintain air volume at setpoint independent of system static pressure. Airflow setpoint adjustable from BAS.

Unoccupied

Mode: Boxes designated as “constant volume” continue to operate as per normal operation mode.

System

Stop: On shutdown of associated AHU system, supply air damper of terminal unit boxes goes to fully open position. Hot water valve V1 on reheat coil shall modulate to maintain room temperature. Perimeter heating valves (V2) remain open and modulate to maintain space temperature setpoint.

Fire Alarm: N/A

Schedule: 24/7

Alarm: F1 Abnormal terminal unit air flow.
T1 Space temperature out of range – high: 3°C > setpoint; low: 2°C < setpoint
H1 Space humidity out of range – high: 60% RH ; low: 30%RH (where applicable)

Emergency

Power:

CS103 - FAN COIL

Applicable Systems: FC-1 (Qty-2), FC-2 (Qty-1)

System Start: Operator command through the BAS or locally. Provide group command to start fan coil units, and by each individual unit. On start of fan coil unit Fan coil is started by operator command at BAS. Upon signal to start fan coil, Fan Coil Starts through signal to binary contact in fan coil OEM control panel.

Normal Operation: Fan coil will supplement heating and cooling capacity from the VAV system and radiant ceiling panels (for heating).

Fan will be continuously operating to achieve the min ACH as indicated in the DWGs

Fan coil OEM control system maintains space temperature of 24°C (Summer), 22°C (Winter) (adjustable) in response to thermostat.

BAS monitors temperature in room independently from fan coil controls through Space Temperature sensor.

System Stop: Fan coil is stopped by operator command at BAS. Upon signal to stop fan coil, Fan Coil Stops through signal to binary contact in fan coil OEM control panel.

Fire Alarm: Not applicable.

CS104 – MENTAL HEALTH DOMESTIC WATER CONTROL

Applicable

Systems: Automatic control valves on domestic hot and cold water supplies to mental health patient washrooms.

System

Start: Not applicable.

Normal

Operation: **Valve Commanded to Close**

Healthcare staff person operates an illuminated pushbutton switch⁽¹⁾⁽²⁾⁽³⁾ to command the control valves on the domestic hot and cold water supplies to the selected patient bedroom to close.

- Provide a separate switch for each patient washroom as identified on plans.

While valves are closing, the integral LED light in the pushbutton flashes on a 0.5 sec ON, 0.5 sec OFF period until both valves are proved closed, at which time the LED light will stay ON while the valves are closed. The valves cannot be reopened until they are completely closed.

Valves Commanded to Open – Option

Healthcare staff person pushes the button again to command the valves to open. The LED light turns OFF.

Note: this option requires spring-return valves, fail to open position. Only one endswitch to prove the valve is closed is required.

Note: a facility operator can override control of the valves through the BMS only if the manual pushbutton is in the “valves open” position. If the manual pushbutton is in the “valves close” position, the facility operator shall not be able to override the valves to the open position.

System

Stop: Not applicable.

Fire Alarm: Not applicable.

Smoke

Control: Not applicable.

Schedule: 7/24/365

Alarm: VC* Valve not proved Closed when commanded close after 60 seconds

Emergency

Power: No

Notes:

1. Blue LED.
2. Normally Open pushbutton, contacts to close when valve is selected to close.
3. Provide flush mounted all metal control panel with light grey finish, with a dedicated pushbutton for each room in a 5x5 pushbutton arrangement with three spare spaces.

END OF SECTION

SECTION 275223 - AUDIO VISUAL NURSE CALL SYSTEM

PART 1 - GENERAL

1.1 OVERVIEW

- A. Provide a complete working Audio Visual Nurse Call System based upon the specification outlined here to include all necessary devices that provide the functions listed in this specification for Waypoint Centre for Mental Health Care. This facility will be referenced as the OWNER in this specification.
- B. If an operational function is specified that requires hardware or software to complete that specific function, then consider that software or hardware part of this specification. The cost of any omissions of software or hardware necessary to complete all operational functions outlined in this specification shall be borne by the contractor providing this system.
- C. All devices shall be ANSI/UL-1069 listed. This includes routers, hubs, switches, and room control devices. Field wiring shall be CAT 5E or CAT 6 cable, control wiring for power distributions and very long runs, and utilize an optional fiber backbone (when distances exceed normal Ethernet limitations). All station equipment shall use plug on connectors and all switches, routers and controllers shall utilize standard RJ-45 modular connections. All remote devices utilizing standard structured cabling shall be capable of PoE (Power over Ethernet) or power supplied within the CAT 5E or CAT 6 cable jacket. Systems which require separate DC power to devices, remote power supplies, or heavy DC wiring to each individual room shall not be accepted. Wiring shall be capable of either being installed in conduit or cable trays, where shown on the plans.
- D. The system shall be capable of interconnecting with the facility's LAN (Local Area Network). This connection shall be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection to accomplish all information exchange.
- E. The OWNER will provide one VPN connection. One VPN is for the servicing contractor to diagnose any maintenance issues and to maintain the system offsite. Diagnostic software should be web based and permit e-mail notification of high level alarms. All software applications shall be HIPAA (Health Insurance Portability and Accountability Act) and PIPEDA (Personal Information Protection and Electronic Documents Act) compliant and shall allow for resident name aliases and alternative display methods.
- F. Overall, Nurse Call System shall utilize VoIP communications between the nurse consoles, wireless telephones, and controllers. Any nurse call console must be able to answer any resident call placed in the network. The communication standard shall be SIP protocol when wireless telephones are integrated. The OWNER will not be providing any analog ports to the nurse call network. As part of this contract, the OWNER will either supply or establish that there is a telephony call network which supports the SIP protocol within the OWNER'S facility. Systems requiring digital to analog converters will not be accepted.

1.2 REFERENCES

- A. Underwriter's Laboratories ANSI/UL-1069 Standard for Safety for Hospital Signaling and Nurse Call Equipment, current release.
- B. Canadian Standards Association.
- C. National Fire Protection Association (NFPA) 70 and 99.
- D. National Electrical Manufacturers Association (NEMA) installation standards

1.3 SYSTEM DESCRIPTION

- A. System hardware shall consist of a nurse call network comprised of VoIP nurse consoles, nurse call network controllers, resident stations, power supplies with battery back-up, dome lights, pull cord stations, emergency push button stations, wiring and other options such as bed side-rail interfaces, computer interfaces, wireless/telephone network interfaces, and a Real-Time Location System (RTLS) interface as shown on drawings. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed to provide a complete and operating system.
- B. System hardware and firmware shall be the product of a single, reputable manufacturer with a proven history of product reliability and sole control over all source code. Manufacturer shall provide, free of charge, product firmware/software upgrades for a period of one year from date of installation for any product feature enhancements. Manufacturer shall provide a 5-year warranty on all manufactured hardware. System configuration programming changes shall not require any exchange of parts and shall be capable of being executed remotely via a VPN connection. Any supplier whose equipment cannot support remote system configuration programming and diagnostics via VPN or requires the exchange of parts, chips for system configuration programming changes will not be acceptable.
- C. All programming and firmware changes shall be accomplished on the working system without interruption to the normal operation of the system. Therefore, all system switches and controllers, which hold this firmware and system parameters must have DUAL storage. While updates are being made to one set of firmware, the system shall be working and fully functional on the original firmware (i.e. A and B memory blocks). It shall be possible to switch to the NEW system control software modules by a single system command. In the event of an error or failure in the update process, the system shall revert back to the previous firmware.
- D. All wall mounted stations shall be mounted using snap tight cover plates. Sub plates shall be slotted and adjustable for trimming the mounting for "squaring" the vertical and horizontal fit. All screws shall be hidden.
- E. All station buttons shall use a bio-seal cover to facilitate the use of disinfectant cleaners.
- F. Entire Network shall be supervised, including all sub-stations. Reporting of station failure shall be to any designated console, PC, e-mail, or wireless device. Remote diagnostics shall be utilized to quickly locate the source of the problem.
- G. Up to 6 different staff levels may be defined within the nurse call network to facilitate workflow within and outside of normal nurse call activity (i.e. cafeteria, therapy rooms, environmental services, etc.).
- H. Nurse call network shall support a VLAN configuration to separate activity in the nurse call network from other facility LAN traffic. Nurse call network can span multiple subnets on a facility's LAN.
- I. All specified equipment shall be manufactured using surface mount technology (SMT) and manufacturing testing shall utilize ATE (Automated Test Equipment) to assure the highest quality production. Specifying authority may request test procedures and/or results of tests on specific equipment being supplied. Manufacturer's testing procedures must be available upon request, including test equipment's model number, serial numbers and date of last calibration.
- J. The nurse call network shall support a GUI interface that sits on the facility LAN. This interface shall provide an active call display board showing selectable data such as call type, call location, and resident name. The interface will also be used to provide historical call detail reports and exception reports.
- K. The nurse call network shall support up to 255 call processes to facilitate workflow and call escalations to various staff levels and/or groups.
- L. Nurse call network shall support any telephone device via the SIP open architectural interface.

- M. Nurse call network shall support any data backup system.
- N. Nurse call network shall provide data reporting capability for use in determining call response times, call types, exception reporting, and resident-level reporting data.
- O. Nurse call network shall interface to an Admission, Discharge, Transfer (ADT) application using a RESTful API or standard HL7 interface to provide automatic updates on resident room/bed assignment.

1.4 WARRANTY

- A. The supplying contractor shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of one year from the date of acceptance.
- B. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the 1-year warranty period for any product feature fixes.
- C. In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, resident stations, sub-stations, and nurse consoles shall extend to a total of at least five (5) years. Warranty for ancillary devices such as pillow speakers and call cords shall extend to a total of at least two (2) years.
- D. After the acceptance of the system(s), service shall be provided on the following basis.

Emergency Service

Provided **24 hours a day**. When a **total or catastrophic failure** of equipment is reported to contractor, within **2 hours of notification**, a service person will be on site. (An example of a catastrophic failure would be a hub failure or a nurse console failure.)

Routine Service

Provided **within 4 business hours** (9 a.m. to 5 p.m., Monday through Friday, excluding holidays) **of notification**. When a minor failure of equipment is reported to contractor, a service person will be on site within 24 hours of notification. (An example of a minor failure includes peripheral equipment such as control stations, entertainment speakers, corridor lights, pull-cord stations, etc. which normally affect only one resident or resident room.)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The products specified shall be new and of the standard manufacture of a single reputable manufacturer. As a reference of standard and quality, functionality and operation, bids to be based on Responder 5000 manufactured by Rauland-Borg Corporation.

2.2 NURSE CALL NETWORK WIRING

- A. All Nurse Call Network wiring shall be only CAT 5E or CAT 6. Plenum wire shall be used in open areas and standard CAT 5E or CAT 6 within conduit. System shall be capable of injecting DC power into a CAT 5 or CAT 6 run, for additional rooms, or long runs, by running a separate DC cable pair to a remote location.

2.3 NURSE CALL CONTROLLER(S)

- A. Each controller shall provide the following:
 - 1. Communications between consoles and rooms, sub stations and pillow speakers, within each station loop.

2. CAT 5E or CAT 6 wiring standard utilizing PoE (Power over Ethernet) between console and nurse call controllers and local wiring to power room station equipment and dome lights.
 3. Up to 92 corridor lights and/or bus devices can be operated with a single controller.
- B. Controller must be life safety grade meaning that it shall not require regular rebooting for continued basic functions of system and it shall be possible for controller to act as a stand alone controller should loss of network communication occur. Personal Computers may not be used for this purpose. PCs will only be allowed outside of the UL-listed nurse call network on the customer supported LAN.
- C. Nurse call controller(s) are connected to the facility's LAN via Ethernet switches. The nurse call servers also connected to the facility's LAN are running specialized software for using facility data resources and/or telephone communications resources.

2.4 VoIP NURSE CONSOLES

- A. Furnish as shown on plans, a ANSI/UL-1069 listed VoIP nurse console capable of the following functions:
1. Color display
 2. 12 or 24 hours time display and synchronization to the optional Reporting server including any daylight savings time changes supported by the server.
 3. Display up to 3 incoming calls each with an individual elapsed timer which increments time since call was placed. Also provides the ability to scroll to see more incoming calls.
 4. Power over Ethernet powered connection to ANSI/UL-1069 listed Ethernet controller. No local power supplies required.
 5. Choice of hands-free communications through built in speaker and separate microphone or private handset conversation.
 6. Ability to create up to 32 soft keys, user-configurable, with 4 buttons, 8 screens deep.
 7. Optional tone/mute of calls in progress.
 8. Ability to block all nurse call loudspeaker paging to facilitate a low noise resident environment. Password protection can be enabled to only allow authorized access to audio paging.
 9. Ability to swing an individual room or any group of rooms by touching one labeled touch point. Room(s) and consoles may be located anywhere within facility nurse/resident communications network. A GUI interface, accessible by any designated end user, may also be used to modify coverage of any wireless phone or nurse console.
 10. Console can be programmed to be the receiver of any call that is not answered by another console or can be programmed to receive any call from a console that has failed or has been unplugged, or otherwise not receiving the call (call orphaning).
 11. Ability to dial through built in keypad.
 12. Self-contained unit which shall not occupy more than 88 square inches of desk space and is desk or wall-mountable.
 13. Support manual Staff Follow functions. When Staff Follow is enabled, call-tones for a prescribed area will automatically be forwarded to the room station speaker where staff members are located. Staff location may be determined manually by entering the room number into the console. Pressing the call button on that station shall silence the tones. When a new call is placed, the tones shall automatically be restored.

2.5 PATIENT STATIONS

- A. Provide single patient or dual patient station as shown on plans.
- B. Various patient station modules shall be capable of the following functions:
1. Entertainment audio to be muted when intercom speaker is in use.
 2. One DIN pillow speaker / call cord receptacle per bed.

3. Station shall support an optional module to feature bedside rail controls.
4. Ability to provide lighting control that interfaces directly to low voltage controllers.
5. No dummy plugs required.
6. Cancel button shall cancel any call on this station and any other station in room that is programmed for universal room cancel.
7. Continuous supervision.
8. Ability to service exchange station "hot" without removing system power or powering down the local controller.
9. Ability to program on a per patient station basis, each bed and entertainment/call cord receptacle to custom call priorities.
10. Ability to provide custom printed text, colors, or logos on any pushbutton or faceplate used on the patient stations.

2.6 SUB-STATIONS

- A. Provide, as shown on plans, sub-stations which shall be flush mounted in a single gang box. All sub station cancel buttons will follow the cancel policy as defined in the system configuration. Typically canceling a high priority call can only be accomplished by the station initiating a call, while lower priority calls may be cancelled by any associated station in the room.
- B. Individual sub-stations shall be:
 1. Pull cord station (non-audio model) shall be rated to an Ingress Protection rating of IP68 (IEC 60529) with a replaceable pull-cord, and an easily cleaned surface. The pull-cord shall have a large, easy to pull plastic "bell" attached. This station may be configured to be only cancelable within the room and not cancelable from the nurse console.
 2. Provide an isolated, supervised input for a fire alarm or other auxiliary device.
 3. Tamper-resistant, high security station(s) shall be provided for use in PICU area. The station faceplate shall be constructed of 11-gauge stainless steel and tamper-resistant button(s), speaker, and call assurance light.

2.7 CORRIDOR LIGHTS AND DOMELESS CONTROLLERS

- A. Provide as shown on plans, the proper type of corridor light or domeless controller. Corridor lights shall contain up to five sections, each lighted by a long-life, single-color LED. Each section shall have a diffusion lens which allows for 180 degree horizontal visibility of call lights. The corridor lights shall be capable of the following:
 1. The corridor light shall make use of multiple colors and programmable flash rates and patterns to indicate pending calls, service requirements and staff registration.
 2. Corridor light shall serve as the hub for all room wiring. All field wire connections shall be accomplished using modular connectors.
 3. The Corridor light shall be equipped with a heart-beat LED (visible to service personnel) to indicate that the unit is functioning properly.
- B. Intelligence in the corridor light and domeless controller shall support up to 6 or 16 room devices respectively and allow for the ability of any room station to be associated with any other room in the system. This allows special functions where needed, such as associated call stations and cancelling options, (i.e. door monitoring).
- C. Domeless controllers shall have all the functions of the corridor light, less LED's.
- D. In the unexpected event of communications loss with the nurse call controller, corridor lights and domeless controllers shall enter a local room failsafe mode showing all calls in the hallway via the LED indicators.

2.8 CALL CORDS

- A. Call Cords shall be provided for all patient stations. All Call Cords shall be ANSI/UL1069 listed as an integral part of the core system. Devices which carry only component listings or are otherwise not part of the core system listings are not acceptable.
 - 1. Standard Call Cords: Standard Call Cords shall be pendant type with a single easy to activate call button, DIN style male plug and sheet clip. Cable shall be a maximum of 3 ft (0.9m).

2.9 WIRELESS PHONE DEVICE INTERFACES

- A. The Telephone Interface shall receive, via an Ethernet connection, VoIP connectivity using the standard SIP protocol.
 - 1. The facility will utilize a VoIP/SIP wireless phone system and an IP/SIP PBX. The software module shall directly support an interface through the OWNER provided Telephony/SIP Call server that communicates to the nurse call network. Any nurse call system that only utilizes analog station/trunk ports to communicate with SIP wireless phones will not be acceptable.

2.10 DATABASE MANAGEMENT

- A. Provide standard ODBC compliant databases. Databases shall be able to be backed up using facilities, standard backup processes and disaster recovery methods.

2.11 SOFTWARE APPLICATION

- A. The Software Application shall be provided with the system to allow for nurse call activities display, recording and reporting of system activities, resident management, user management and configurations of the Software Application.
- B. The Software Application shall be installed on an external server which shall in turn be connected to the Nurse Call System.
- C. The Software Application shall support a networked operation connected to the hospital LAN. Users with access to the LAN can then generate reports from local workstations.

2.12 ACTIVITY BOARD DISPLAY

- A. Provide an Activity Board display on up to (10) networked OWNER provided PCs or Smart TVs that meets the system manufacturer's minimum specifications, whether it utilizes touch screen or standard keyboard & mouse control.
- B. Display of all active nurse calls and statuses with up to (11) optional columns of relevant information. The following information, configured by the end user, shall be displayed at each one of these users' screens:
 - 1. Location name.
 - 2. Room name.
 - 3. Bed number/name.
 - 4. Call Type (Help, Code Blue, etc.).
 - 5. Service (Aide, Doctor, etc.).
 - 6. Resident First Name.
 - 7. Resident Last Name.
 - 8. Resident Sex.
 - 9. Resident Age.
 - 10. Doctor Name.
 - 11. Notes (for miscellaneous information).

2.13 REPORTING

- A. Reporting Module shall allow users to generate / print reports on system activity. Access to reports shall be controlled based on username and password. Reports shall be capable of indicating call priority, room number and resident information, call placed time, service reminder set, and staff registration. The following reports shall be provided:
 - 1. Detailed Call Data by Unit
 - 2. Summary Call Data by Unit
 - 3. Summary of Call Data by Room/Bed
 - 4. Summary of Call Data by Resident
 - 5. Exception Report identifying response times exceeding user-defined limits.
 - 6. Contact Trace report when integrated with RTLS system to show physical interaction between staff, residents, and location.
- B. Reporting Module shall allow users to create Template Reports that can be configured and used by the end users on demand, as needed.
- C. Reporting Module shall allow users to create Recurring Reports that will be automatically executed and delivered via email to specific end users recipients, based on a defined configuration. The Recurring Reports shall allow end users to configure the following:
 - 1. Report Name
 - 2. Send To
 - 3. CC
 - 4. How often should the report be sent (Daily, Weekly, Monthly)
 - 5. What day(s) should the report be sent (Sun., Mon., Tue., Wed., Thu., Fri., Sat.,)
 - 6. Select a Report (one of the five reports described in 2.16.2 - B)
 - 7. Start Date
 - 8. End Date
 - 9. No End Date

2.14 RESIDENT MANAGEMENT

- A. Resident Management Module shall allow end users to view residents' details in a table view containing the following columns:
 - 1. Last Name
 - 2. First Name
 - 3. Middle Initial
 - 4. Date of Birth
 - 5. Sex
 - 6. Doctor
 - 7. Location
 - 8. Room-Bed
 - 9. Notes
- B. The Resident Management Module shall allow two methods to manage resident information. End users with the proper rights can manually Add Resident to the system. The following Resident Information data fields shall be available for end users to add:
 - 1. Last Name
 - 2. First Name
 - 3. Middle Initial
 - 4. Date of Birth
 - 5. Sex
 - 6. Doctor
 - 7. Location

8. Room-Bed
9. Notes

- C. The Resident Management Module shall allow end users with proper rights to manually Edit Resident Information from the system. The following Resident Information data fields shall be available for end users to edit:

1. Last Name
2. First Name
3. Middle Initial
4. Date of Birth
5. Sex
6. Doctor
7. Location
8. Room-Bed
9. Notes

- D. The Resident Management Module shall also provide a method to connect to an Admission, Discharge, Transfer (ADT) application using a RESTful API or standard HL7 interface which will automatically update resident information in near real-time as resident information changes. When the ADT is active, manual edits of the resident information shall be prohibited to allow the systems to remain synchronized.

2.15 CHECK-IN FUNCTION

- A. The nurse call system shall provide a method to configure a once-per-day event (alarm) that requires the press of a designated station button within a configurable time window to cancel the event (alarm). The system shall report and display all rooms where the button has not been pressed within the time window. This function can be used as a resident check-in, medication reminder, or any other event which requires a regular, once-per-day activity.

2.16 USER MANAGEMENT

- A. User Management Module shall allow end users to view a complete list of system users in a table view containing the following columns:

1. Username
2. Last Name
3. First Name
4. Middle Initial
5. Unit(s)
6. Last Login
7. Can Edit Residents
8. Active

- B. The User Management Module shall allow end users with proper rights to Add Users to the system. The following User Information data fields shall be available for end users to add:

1. Username
2. Last Name
3. First Name
4. Middle Initial
5. Password
6. Re-type Password
7. User Type
8. Can Edit Residents Details
9. Access to Unit(s)

- C. The User Management Module shall allow end users with proper rights to Edit Users to the system. The following User Information data fields shall be available for end users to edit:

1. Username
2. Last Name
3. First Name
4. Middle Initial
5. Password
6. Re-type Password
7. User Type
8. Can Edit Residents Details
9. Access to Unit(s)

2.17 ACTIVITY BOARD MANAGEMENT

- A. The Activity Board Management Module shall allow end users with proper rights to view a complete list of activity boards within the system.
- B. The Activity Board Management Module shall allow adding of up to (10) Activity Boards to be displayed. The following information, configured by the end user, shall be displayed at each one of these users' screens:
1. Location name.
 2. Room name.
 3. Bed number/name.
 4. Call Type (Help, Code Blue, etc.).
 5. Service (Aide, Doctor, etc.).
 6. Resident First Name.
 7. Resident Last Name.
 8. Resident Sex.
 9. Resident Age.
 10. Doctor Name.
 11. Notes (for miscellaneous information).

PART 3 - EXECUTION

3.1 SUPERVISION

- A. Only factory certified installers shall install, service, and maintain the specified network system.
- B. Manufacturer shall have the equipment manufacturer's engineer or their designated agent inspect the installation and operation of this network to determine that the network complies with all standards listed.

3.2 IN-SERVICE TRAINING

- A. Contractor shall provide thorough training of all staff assigned to those units receiving new networked nurse/resident communications equipment. This training shall be developed and implemented to address two different types of staff. Floor nurses/staff shall receive training from their perspective, and likewise, unit secretaries (or any person whose specific responsibilities include answering resident calls and dispatching staff) shall receive operational training from their perspective. A separate training room will be set up that allows this type of individualized training utilizing in-service training unit, prior to cut over of the new system.

3.3 WIRING

- A. Contractor shall terminate all wiring with manufacturer approved connectors. The use of wire nuts is prohibited.

- B. All wiring shall be free from shorts and faults. Wiring shall be UL listed, NEC and NFPA 70, Article 25 approved.
- C. Wiring shall not be run in the same conduit with other systems (i.e. Class 1 AC power distribution, fire alarm, entertainment systems, lighting controls, etc.).

3.4 ELECTRICAL POWER CONNECTIONS

- A. Provide a dedicated 120 VAC, 60 HZ conduit feed into the equipment cabinet. This power feed shall not have any other devices connected directly to it. A 20 AMP circuit breaker located in the electrical sub-panel labeled "nurse call" will control this circuit.
- B. Connect all network system power supplies and equipment cabinets to a common earth ground utilizing a 14 AWG, or larger, solid conductor which is at minimum the same conductor size as the AC feed wires.

3.5 PROTECTION OF NETWORK DEVICES

- A. Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved ESD wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

END OF SECTION

SECTION 281301 - SECURITY SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE

- A. Read and be governed by Section 26 05 01.
- B. Abbreviations and Acronyms:
 - 1. ACAM Access Control and Alarm Monitoring
 - 2. CCS Common Cabling System
 - 3. CCTV Closed Circuit Television System
 - 4. CNE Common Network Equipment
 - 5. DGP Data Gathering Panel
 - 6. DPS Door Position Switch
 - 7. IP Internet Protocol
 - 8. GUI Graphical User Interface
 - 9. LAN Local Area Network
 - 10. LCD Liquid Crystal Display
 - 11. LED Light Emitting Diode
 - 12. NVR Network Video Recorder
 - 13. PC Personal Computer
 - 14. PIN Personal Identification Number
 - 15. PoE Power over Ethernet
 - 16. RF Radio Frequency
 - 17. RFI Request for Information
 - 18. RFID Radio Frequency Identification
 - 19. SCC Security Control Centre
 - 20. SMS Security Management System
 - 21. TCP Transmission Control Protocol
 - 22. UPS Uninterruptible Power Supply
 - 23. VLAN Virtual Local Area Network
 - 24. VOIP Voice Over Internet Protocol
 - 25. WAN Wide Area Network
- C. Reference Documents:
 - 1. National Fire Protection Association (NFPA)
 - 2. NFPA 70, Article 517, National Electric Code.
 - 3. NFPA 101, Life Safety Code.
 - 4. Electronic Industries Association (EIA)
 - 5. REC 12749, Power Supplies.
- D. Reference Standards:
 - 1. Canadian Standards Association (CSA International)
 - a. CSA C22.1-18, Canadian Electrical Code, Part 1 (23rd edition) Safety Standard for Electrical Installations.
 - b. CAN/CSA C22.3 No.9-08 (R2015), Overhead Systems.
 - 2. National Fire Protection Association (NFPA)
 - a. NFPA 70, National Electric Code.
 - 3. Underwriters Laboratories of Canada (ULC)
 - a. S317-1996, Installation and Classification of Closed-Circuit Video Equipment (CCVC) Systems for Institutional and Commercial Security Systems.

1.2 RELATED WORK

- A. Read and be governed by Section 28 13 11 - Security Systems Integration.
- B. Section 28 46 24 - Fire Alarm System Integration.
- C. Section 25 85 00 - Integrated Workplace Experience Application.

1.3 QUALIFICATION OF MANUFACTURERS

- A. Due to the complexity of the project, only specific security equipment manufacturers will be deemed qualified for this work. Authority to determine these manufacturers, rest solely and completely with the Consultant.

1.4 PREFACE

- A. The proceeding is a comprehensive specification of the design and resulting requirements for a fully integrated security system to be provided for the Waypoint Toanche building.
- B. The Security Contractor shall observe, understand and comply with all relevant sections of this and other divisions of this document.
- C. For all components provided by others but connected to the security system, the Electrical Contractor shall provide all required conduit c/w pullstring, junction boxes 120VAC power and back boxes. The Security Contractor shall provide all low voltage wiring, hardware, network patch cabling and devices as required to connect components provided by others to the security system for a completely functional and fully operational system.

1.5 SUBMITTALS

- A. Contractor shall, as a minimum, provide the following at the time of bid:
 - 1. A point-by-point compliance checklist indicating whether the proposed solution is compliant with the items included in the specifications.
 - 2. A comprehensive spreadsheet indicating the type and quantity of each device included in the bid. The contractor is responsible to include the complete scope of work as depicted in the drawings and specifications, the device types and quantities submitted will not alleviate any responsibilities to provide the complete specified scope.
 - 3. All manufacturer produced technical data sheets, specifications, literature and photographs for all proposed equipment and devices.
 - 4. Point-to-point diagrams and riser block diagrams demonstrating the contractors understanding of the overall intention of the works. This shall be provided for the base building security systems (access control and video surveillance).
 - 5. Proponent generated literature describing the requirements of the project and their intent and plan to complete the works including, but not limited to, a detailed description of the process and procedures which will be undertaken during the course of the project.
 - 6. A comprehensive project schedule in the form of a Gantt chart.
 - 7. Information about the proposed project manager for the works.
 - 8. Complete information regarding the warranty period for the project including start date, length of coverage.
 - 9. Complete information regarding comprehensive maintenance packages including a sample maintenance contract.

1.6 SUBMITTALS AFTER AWARD OF CONTRACT

- A. Contractor shall submit shop drawings to indicate:
 - 1. project layout.
 - 2. point to point diagrams.
 - 3. cable schematics.

4. Risers.
5. mounting details.
6. identification labelling scheme including functional description of equipment.
7. technical data sheets of all devices and equipment.
8. device location plans and
9. cable lists.

1.7 SCOPE OF WORK AND SUPPLEMENTARY EXPECTATIONS

A. Scope of Work

1. These performance specifications are to be translated into specific devices, equipment and systems which the Security Contractor proposes to use in order to produce a fully integrated security system as specified.
2. In the event of discrepancies within or between the tender documentation, which includes drawings, risers, details and specifications, the Security Contractor shall either raise the issue via the RFI process before the project is awarded or include for the most onerous requirement.
3. These tender documents are to be read in conjunction with the electrical and door hardware contract documents. In the event of discrepancies within or between the tender documentation, which includes drawings, risers, details and specifications, the Contractor shall either raise the issue via the RFI process before the project is awarded or include for the most onerous requirement.
4. The owner reserves the right to modify, adjust and append the scope and extent of work described within this document at any time.
5. Security Contractor shall provide (supply, install, configure, test and commission) a network (IP) based, centrally controllable and fully integrated security systems consisting of, but not limited to, access control and alarm monitoring (ACAM), intercommunications, duress and video surveillance systems.
6. The Security Contractor is responsible for providing and implementing a fully functional security system. Except where confirmed otherwise, all equipment including, but not limited to, all low voltage wiring, network patch cabling, cabinetry and enclosures, field devices, power supplies, hardware, software, licenses and all other materials needed to produce a fully operational security system shall be provided by the Security Contractor. The Electrical Contractor shall provide all 120VAC power, conduit and back-boxes, except were indicated otherwise.
7. The Door Hardware Contractor shall provide for all electric strikes, electromagnetic locking devices, electric locking devices and door position contacts. The Security Contractor shall coordinate with the Door Hardware Contractor to ensure that the doors and frames are appropriately prepped to support access control devices as specified and shown on the drawings.
8. All security low voltage wiring, and communication cabling used by security hardware shall be enclosed in minimum 21mm conduit unless indicated otherwise.
9. The Security Contractor shall apply for all required permits, including a separate electromagnetic lock permit. Permit fees shall be included in the tender sum.
10. The Security Contractor shall be responsible for coordinating, programming and entering all systems information into the various security sub-systems including, but not limited to, all access control user databases and user access levels, the provision of and programming of all dynamic mapping functions available by the chosen software package for both the access control and video surveillance systems (access control dynamic mapping shall display all devices which register as an event or alarm on the access control system).
 - a. This shall include coordination with the Master Technology Integrator (MTI) and Electrical Contractor, where required, to achieve the integrations, digital enablement, and use-cases associated with the Security System at Waypoint Toanche and specified under Section 28 13 11.

- b. The Security Contractor shall be responsible to coordinate with the MTI to enable the application of Mobile Access Credentials via a third-party Workplace Tenant Experience Mobile App to interface with card readers at Waypoint Toanche as specified under Section 25 85 00.
- c. The Security Contractor shall be responsible to Coordinate with the MTI and Electrical Contractor for the digital enablement of the Security System for integration with the Fire Alarm System (provided by the Electrical Contractor) including all required data-points, workflows, and outcomes as specified in Section 28 46 24 to achieve the intersystem integration strategy at Waypoint Toanche.
- 11. The Security Contractor shall verify that all cable runs from IP devices to the nearest network switch locations do not exceed ninety (90) metres. For those runs that exceed the distance limitation, the Contractor shall provide PoE-extenders with additional CAT 6 cabling as well as all required terminations, connections, power supplies and hardware for a fully functional video surveillance system.
- 12. The Security Contractor shall provide the required low voltage wiring, connections, terminations, programming and configuration such that all vehicular overhead roll-up doors can be opened/closed remotely from the security system workstations. The Security Contractor shall coordinate with the Overhead Door Supplier to achieve the required functionality.
- 13. The security system shall reside on the converged building network provided by the Communications Contractor.

B. Ancillary Expectation

- 1. Waste Management and Disposal
 - a. Separate and recycle waste materials in accordance with construction/ demolition waste management and disposal literature.
 - b. Remove from site and dispose of all packaging materials at appropriate recycling facilities.
 - c. Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with waste management plan.
 - d. Fold up metal banding, flatten and place in designated area for recycling.
- 2. Cleaning, Maintenance and Extra Materials
 - a. All equipment and devices shall be provided by the Security Contractor in new, clean and unmarked condition.
 - b. Protective coverings shall be removed from all equipment prior to system start-up and use.
 - c. All devices including video cameras and request-to-exit motion detectors are to be properly adjusted for correct purpose and function.
 - d. Security Contractor to provide necessary security system maintenance materials as well as any unused or auxiliary materials to the Owner.

1.8 ITEMIZED, SEPARATE AND ALTERNATE PRICING

- A. Itemized pricing is the specific cost for a described scope of work which is included in the base bid.
- B. Separate pricing is the specific cost for a described scope of work which is not included in the base bid.
- C. Alternate pricing is the net total costing for the deletion of a specified scope of base bid work for an alternate scope of work.

1.9 QUALITY OF INSTALLATION

- A. The Security Contractor provides a qualified, thorough and professional installation crew.
- B. The Security Contractor must be a certified re-seller of all products used to fulfil this contract.
- C. The Security Contractor's technicians must be certified installers of the software/hardware components used to fulfil this contract.
- D. The Security Contractor must clearly disclose in their proposal any and all instances where a sub-contractor is proposed to be used.
- E. During installation, the Security Contractor must observe, understand and obey all site safety rules and regulations. Moreover, all pertinent codes as well as proper practice in procedure must be adhered to.
- F. The system shall be installed as required in proper conduits. The Security Contractor shall provide all miscellaneous parts, equipment, and labour necessary to ensure complete and correct operation of the system.
- G. All installed wire, cable and conduit must be of the correct type, quantity and size as specified and required by the manufacturer.
- H. The Security Contractor is to gain consent from the Owner or Owner's appointed project manager in order to begin installation.
- I. Materials and Products Utilized
 - 1. All equipment, devices and subsidiary materials shall be in accordance with applicable CEMA and NEMA specifications, as well as be CSA/ULC approved.

1.10 SOFTWARE UPDATES AND REVISION

- A. Upon completion and directly preceding the initiation of manufacturer warranties, the Security Contractor is to update all system related software with the most current available edition (which must be confirmed with the consultant and Owner IT representative) devoid of added expense to the Owner. Owner must approve any software upgrades that shall be implemented to the system.

1.11 SYSTEM DOCUMENTATION

- A. The Security Contractor is required to present adequate documentation covering the entire scope and extent of completed work, including but not limited to:
 - B. Theory of Operation - System outline and overview.
 - C. Database Setup - Description of details required to prepare the system for implementation, including system planning forms and entry examples such as syntax, etc.
 - D. Alarm Processing - Submission of operational manuals explaining the system operator's available functions and capabilities while using the central control unit.
 - E. Management Breakdown - Description of administrative functions required to supervise and manage the system.
 - F. Product Manuals - Delivery of complete manufactures manuals for all system software and hardware components.
 - G. As-Built Drawings – Delivery of complete as-built drawings documenting the complete installed scope of work, all installed field devices for all systems, all head end and back-end equipment, conduit routes, point-to-point riser and connection diagrams depicting the complete final architecture and of all security sub-systems.

1.12 SYSTEM TRAINING AND INSTRUCTION

- A. The Security Contractor is to include for a minimum of twenty (20) hours of training for the security systems.
- B. The Security Contractor shall coordinate all training sessions with the Owner prior to substantial completion.
- C. System instruction is to include complete information regarding both system operations and management. Training sessions must be clearly identified and broken down into significant topics. Furthermore, the number and types of training classifications must be made available.
- D. All training sessions must be filmed or captured via video and provided to the Owner.

1.13 TESTING AND QUALITY ASSURANCE

- A. Testing shall be performed following the mechanical and electrical completion of each major section of the system.
- B. The Security Contractor shall provide a complete commissioning testing script (covering all sub-systems including access control and video surveillance) to the consultant for review prior to any final system testing or commissioning. Once the approved commissioning testing scripts have been completed, the Security Contractor will submit them as part of the as-built and close out documentation.
- C. The Security Contractor shall ensure all appropriate software modules are functioning as designed.
- D. At the discretion of the Consultant, final acceptance testing shall be carried out at the following defined levels: per point basis; per system basis; per software function basis; per total system basis; and per power load basis.
- E. The Security Contractor, under supervision of the equipment manufacturer is to test and verify the proper installation and functionality of the system. Any and all costs associated with providing on-site manufacturer professional services shall be included for. Sufficient manufacturer professional services shall be included to allow for the review and approval of the installation of the access control and video surveillance systems by the manufacturers.
- F. Security Contractor shall inspect and test all wires and cables traveling to and from system devices and equipment. Security Contractor to verify that the removal of a device or disconnection of wiring will cause the trouble signal to correctly trigger under open circuit, short circuit, ground fault and removed receptacle conditions.
- G. Security Contractor shall inspect all system installed equipment for visible damage or tampering which may interfere with the intended system function.
- H. Security Contractor shall test all devices which are field adjustable to ensure the proper settings are realized under ambient conditions at the location of installation.
- I. Security Contractor shall operate all initiating devices to verify proper operation.
- J. Security Contractor shall inspect system power supplies to ensure all are properly fused, locked away from unauthorized interruption, adequate to meet system requirements and separated from auxiliary device power.
- K. Security Contractor shall inspect all battery units for protection from accidental damage and adequate ventilation. All batteries shall be permanently connected to a properly fused charging circuit dedicated for system batteries.
- L. Security Contractor shall test all control equipment for acceptable operation. Inspection and testing of all cable terminals, plug connectors, plug-in circuits, lamp sockets and controls shall be confirmed to have proper mechanical and electrical connections, mountings and, where applicable, electrical supervision.

- M. Security Contractor shall verify that field wiring is terminated on a single conductor per terminal basis.
- N. Security Contractor shall test all lamps and indicators for acceptable operation. All control functions are to be tested to verify correct response. Simulation of open circuits, short circuits and ground faults on all relevant components are to be completed in order to confirm proper trouble circuit response.
- O. Security Contractor shall test ancillary equipment connections for proper operation and inspect such equipment to ensure no faults will interfere with security system procedure.
- P. Security Contractor shall test all video camera, surveillance and monitoring equipment during both light and dark conditions to verify correct function and lens selection.
- Q. On completion of all tests and verification, the Security Contractor shall provide a certificate indicating proof of liability insurance.

1.14 SERVICE AGREEMENT REQUIREMENTS

- A. The successful Security Contractor may be required to enter into a separate service agreement with the Owner. The service agreement shall not take effect prior to the certification of substantial completion. The Security Contractor will be required to provide seven (7) day per week, twenty-four (24) hour per day call back service, with a guaranteed time of response for "emergency" and "non-emergency" call backs. Security Contractor is to identify a separate price for service agreements.

1.15 REQUISITE WARRANTIES

- A. All materials provided by the Security Contractor shall have a minimum warranty of twelve (12) months from the certification of substantial completion.

PART 2 - PRODUCTS

2.1 SECURITY SYSTEM COMPONENTS AND FEATURES

- A. The security management system shall consist, but not be limited to, the following components:
 - 1. UPS power supplies
 - 2. Data gathering control panels.
 - 3. Data gathering control panel battery backup power supply units.
 - 4. HID Signo card readers (contactless smart cards)
 - 5. iCLASS access cards
 - 6. Electromagnetic lock power supply units
 - 7. Electric locking device power supply units
 - 8. Electromagnetic locks
 - 9. Electronic locking device complete with integral request-to-exit device.
 - 10. Fail secure electric door strikes.
 - 11. Door position switches
 - 12. Overhead door position switches
 - 13. Request-to-Exit pushbuttons
 - 14. Request-to Exit motion sensors.
 - 15. Low voltage wiring
 - 16. CAT 6 Communication cabling
 - 17. Panic Buttons
 - 18. Emergency Duress Stations
 - 19. IP Cameras (Fixed, 180, 360))
 - 20. Analogue Cameras
 - 21. Analogue Camera Power Supplies
 - 22. IP Intercommunication stations – Main and Substations

23. Intercommunication System Server
24. Intercommunication System Software
25. Security system workstations and peripheral devices (monitors, keyboard, mouse, PTZ control joysticks)
26. Software and licenses
27. Camera lenses
28. Camera housings and mounting brackets
29. Security enclosures and equipment racks

2.2 SPARE EQUIPMENT

- A. Security Contractor shall supply spare components that will be made available for the ongoing maintenance of the Works.
- B. Security Contractor shall include in their submission an amount equal to a minimum of 5% of the material cost (not including installation cost) of all equipment that makes up their proposed systems, including but not limited to, cameras and mounting accessories, card readers, request-to-exit devices, access reader controllers, power supplies, back-up batteries and input/output modules. The nominal value carried for spare equipment shall be provided in the Tender Form and spare parts requirements shall be coordinated with the Owner prior to procurement.
- C. Owner will store spare equipment on-site for replacement. The Security Contractor shall return swapped-out equipment for warranty replacement and spare supplies shall be restocked once new equipment is procured.
- D. At the time of the first site acceptance and sign off, the Security Contractor shall deliver all spares.

2.3 SYSTEM CABINETRY, ENCLOSURES AND RACKS

- A. Security Enclosure
 1. All cabinets, enclosures, racks and housings having doors or removable covers and containing terminals, P/C hardware or their power supplies, shall be provided with cover operated, corrosion resistant, tamper switch devices. Tamper devices shall be arranged to actuate an alarm signal when the door or covers are moved as little as 1 cm (3/8") from its normally closed position.
 2. All controls which affect unit sensitivity shall be located inside the tamper resistant enclosure.
 3. Provide high security key locks or key operated cabinet switches.
- B. Tamper Switching
 1. The tamper switch unit shall remain inaccessible until the switch is activated and shall have concealed mounting hardware so that its location cannot be visually detected from the exterior of the enclosure.
 2. The switches shall remain under supervision at all times, whether or not their circuits are in the authorized access or secure modes.

2.4 DATA GATHERING PANELS (CONTROLLERS)

- A. General
 1. All data gathering panels shall be RBH Axiom V.
 2. All Access Control functionality shall be contained in the data gathering panel (DGP) and its accessories. Data gathering panels shall be connected to the System Server through the designated network ports. Each network central controller shall support up to a maximum of eight (8) readers. The maximum number of supervised inputs per controller shall be one hundred and ninety-nine (199). The maximum number of relay outputs per controller shall be one hundred and ninety-nine (199).

B. Hardware

1. Each data gathering panel provides up to a maximum of sixteen (16) supervised inputs, eight (8) relay outputs and shall support a maximum of (8) readers, eight (8) input modules and eight (8) output modules. The DGP shall support the option of direct or indirect Wiegand reader connections. Wiegand readers directly connected to the DGP may reside up to 500 ft. from the DGP with the proper AWG wiring. Indirect Wiegand readers shall be connected via reader modules and may reside up to 4000 ft. from the DGP via a properly wired RS-485 bus. Each controller shall support up to eight (8) different card formats. Each card format shall support fifty (50) company and site codes. The card formats shall be assigned to any of the card readers.

C. Power Requirements

1. Each data gathering panel shall accept a regulated input voltage and generate appropriate voltage levels for on-board use as required. The input supply voltage shall be bussed directly to the reader bus connectors to supply operating voltages for reader and input/output modules. The DGP shall provide a configuration jumper which shall allow either +12VDC or +5 VDC to be supplied the external read heads connected via the direct Wiegand ports. All Wiegand readers connected to the Wiegand ports shall have the same power requirements or an external power supply shall be required.

D. LED Indicators

1. Each DGP shall provide LED indicators for the following functions:
 - a. Power
 - b. Data for the RS-485 communications ports
 - c. On-board relay activation

E. Connectors

1. All DGP connectors shall be screw down type and pluggable to facilitate field replacements and simplify testing.

F. Reader Ports

1. There shall be a maximum of eight (8) RS-485 ports provided, per DGP, for connecting external reader modules and input/output modules. An end-of-line (EOL) termination resistor shall be provided for each port to satisfy RS-485 multi-drop requirements. The EOL termination for each RS-485 port may be individually disabled via an eight (8) position DIP switch to allow the controller to reside in the middle of an RS-485 reader chain.

G. Direct Wiegand Reader Connections

1. The controller shall provide for direct connection of Wiegand read heads. The read heads connected to these ports shall conform to the industry standard Wiegand Output format and shall support multiple card technologies including magnetic stripe, Wiegand, proximity, barium ferrite, bar code and biometrics. Any unused direct Wiegand ports may be individually disabled.

H. LED Control

1. In addition to accepting card data from the read heads, the DGP shall control the LED's at the reader, supporting industry standard 2-wire or 1-wire control. The DGP shall also provide a signal line to control an external beeper at the reader with an active low going signal. The LED control shall support three LEDs - red, amber and green. The System Server shall support the configuration of these LEDs such that certain LEDs shall illuminate or not illuminate or pulse to indicate various System status conditions.

I. Wiegand Keypad Support

1. The direct Wiegand reader ports shall support Wiegand readers with integrated Wiegand output keypads. The supported data format shall conform to industry standard 4 bit or 8 bit (4 bits plus 4 bits complimented) Wiegand keypad data.

J. Supervised Inputs

1. Sixteen (16) Class A Supervised inputs shall be provided on each DGP. All supervised inputs in the system shall require EOL terminating resistor networks.
2. Each DGP shall support eight (8) Input boards, providing an additional sixty-four (64) supervised inputs to each DGP.
3. The System Software Administrative Application shall support the configuration of all supervised inputs connected to the DGP. The Monitoring Application Interface shall provide the current status of the inputs and shall log changes in input status. Supervised inputs shall be able to be taken offline for diagnostic purposes and each input shall support being linked directly to an output or to a system event. All input activations shall be reported to the Monitoring Application and stored in the Historical Journal on the System Server.

K. Outputs

1. Each DGP shall provide eight (8) form C, general-purpose, dry contact relay outputs, which are user configurable.
2. Each DGP shall support eight (8) output boards, providing an additional sixty-four (64) outputs to each DGP.
3. The System Software Administrative Application shall support the configuration of all outputs connected to the DGP. The Monitoring Application Interface shall provide the current status of each output and shall allow the manual activation of each output individually or in user-defined groups for diagnostic purposes.

- L. Each panel shall contain a minimum of 1 (one) spare point for future use.

2.5 ENTRY SYSTEMS

A. Card Access System

1. The card access system shall be an extension of the existing RBH based access control and alarm monitoring system currently existing on site.
2. The system must support the existing credential technology currently deployed on site.
3. It shall be possible to provide a system capable of responding to cards only, card and pin/key pad, or two cards within a time period.
4. The system shall support a minimum of fifty thousand (50,000) cards and shall be capable of supporting an unlimited number of users.
5. When a card is presented at a reader information from the card will be read and processed first by the DGP and, if necessary, by the central computer controller. On a "go" command only, the locking device will be unsecured for a predetermined time period.
6. Momentary and maintained locking as well as unlocking commands shall be supported directly from the central controller keyboard.
7. Readers shall be capable of incorporating a connection for a "Request to Exit" device to release the locking device from the inside of secure areas. Each door controlled by an access reader will have an associated door contact monitored by the nearest DGP to allow for constant monitoring of the door status.
8. An alarm shall be created if the door is held open for longer than a pre-set field adjustable period of time between zero and sixty (0-60) seconds. The generated alarm shall reset automatically once the door is closed and transmit a "door closed" message to the system central controller. Forced door entry alarm signals and door held open alarm signals shall be monitored by the DGP with alarms annunciating at the central controller.
9. Entry shall be denied if an invalid system card has been badged through a reader, and an alarm shall be annunciated at the central console.

10. Readers shall be fitted with status indicator LED's, green to indicate that access is granted, red to indicate that entry is denied, or door is in secure mode. Weigand card readers shall be equipped with inherent son alert type sounders which shall, when a controlled door is being held open, sound an audible alarm pre-alert prior to the activation of the Door Held open alarm relay. The timing of this feature shall be fully user programmable in order to provide maximum flexibility in the prevention of false door held open alarms.
11. If a pin/keypad is used, the code shall be entered directly after the access card has been read by the reader. Incorrect pin numbers shall generate an error message on the central controller.
12. The system shall also provide the user with the capability of designating individual cardholders as barrier free. Each barrier free designated person shall be permitted via system programming to hold card reader-controlled doors open longer than non-barrier free individuals. The door lock shall remain unlocked longer for barrier free individuals (user programmable).

2.6 CARD READERS

A. HID Signo 40 Multi-Technology Contactless Smart Card Reader:

1. Guaranteed compatibility to read all HID data formats and ensuring card-to-reader interoperability in multi-location installations and multi-card and reader populations when used with Genuine HID products.
2. Simultaneously support of BLE Mobile Devices, NFC Mobile Devices, 13.56MHz and 125Khz contactless credentials. The contactless smart card reader shall read Mobile IDs powered by the Seos standard based software application or applet technology.
3. The contactless smart card reader must support the following 2 modes of interaction with BLE credentials:
 - a. Tap Mode: The mobile device must be brought very close to or touching the reader (a similar user experience to that observed using Prox cards)
 - b. Twist and Go: The mobile device holder must initiate the read by twisting the mobile device in using a sharp 90° rotation in either direction.
4. The Card Reader shall come with integral keypad for dual authentication where required.
5. Ease of installation through identical wiring methods as legacy 125 KHz proximity readers.
6. The ability to read expanded smart card data format lengths up to 144 bits.
7. Backwards compatibility with legacy 125 KHz proximity access control formats (E.g. 26-bit, 32, 35-bit, 37-bit, 56-bit, and HID Corporate 1000 formats).

B. HID Signo 20 Multi-Technology Contactless Smart Card Reader (mullion mount):

1. Card readers shall utilize Open Supervised Device Protocol (OSDP).
2. Guaranteed compatibility to read all HID data formats and ensuring card-to-reader interoperability in multi-location installations and multi-card and reader populations when used with Genuine HID products.
3. Simultaneously support of BLE Mobile Devices, NFC Mobile Devices, 13.56MHz and 125Khz contactless credentials. The contactless smart card reader shall read Mobile IDs powered by the Seos standard based software application or applet technology.
4. The contactless smart card reader must support the following 2 modes of interaction with BLE credentials:
 - a. Tap Mode: The mobile device must be brought very close to or touching the reader (a similar user experience to that observed using Prox cards)
 - b. Twist and Go: The mobile device holder must initiate the read by twisting the mobile device in using a sharp 90° rotation in either direction.
5. The Card Reader shall come with integral keypad for dual authentication where required.
6. Ease of installation through identical wiring methods as legacy 125 KHz proximity readers.
7. The ability to read expanded smart card data format lengths up to 144 bits.

8. Backwards compatibility with legacy 125 KHz proximity access control formats (Eg. 26-bit, 32, 35-bit, 37-bit, 56-bit, and HID Corporate 1000 formats).

2.7 ACCESS KEY CARDS

- A. All cards shall be encoded with the same customer or facility code.
- B. They shall have a unique ID number, which together with the customer or facility code is a non-duplicated entity.
- C. They shall be resistive to wear and deterioration from normal environmental elements.
- D. Cards shall be guaranteed against the activation of any other card access system or anti-theft devices.
- E. Access cards shall be used with access readers to gain entry to access controlled areas (e.g. doors, gates, turnstiles) and to hold information specific to the user.
- F. The system smart cards operate on the industry standard frequency of 13.56MHz
- G. Minimum Read & Write credentials:
- H. HID iClass: Memory capacity: 32K bit with 2 application area configurations.
- I. MIFARE: 4k Bytes
- J. HID-iClass credential shall have a minimum of 16 kb, 32kb preferred, of available memory and allow the possibility for use with multiple vendors across multiple applications.
- K. Access profile for the individual user, encoded on to the card, shall be encrypted and in such a format as to negate the potential for cloning.
- L. Standard 16 kb, 32kb preferred memory on each credential shall be secured with a unique set of Keys A&B for the Electronic Access Control (EAC) system and to enable, as and when required, the collection and transfer of information pertaining to audit trails, lost and stolen cards etc via a data on card functionality.
- M. Secured RFID contactless smart cards
- N. Contactless smart card technology provides high-speed, reliable communications with data integrity.
- O. Ensures high security with mutual authentication, encrypted data transfer.
- P. Read/write capable.
- Q. Multi-application cards: capable of storing information for future applications or integration.
- R. The cards shall meet the following standards for contactless smart cards:
- S. ISO 15693 and ISO 14443B2.
- T. Presentation to the access control reader at any angle within a minimum of one (1) inch shall result in an accurate reading of the card.
- U. The cards shall possess a unique 64-bit, fixed card serial number, used for anti-collision and key diversification.
- V. The cards shall support read/write capability, with a minimum of two (2) Kbits 256 bytes of EEPROM memory. The two (2) Kbit card shall have a minimum of two (2) application areas. Data retention shall be ten (10) years, nominal. Wiegand card data up to eighty-four (84) bits in length shall be factory programmed in application area one (1) for use with access control systems.
- W. Each application area on the cards and fobs shall be secured with a sixty-four (64) bit unique, diversified security key, such that data stored in that area cannot be accessed or modified until the card and reader have completed a mutual authentication process.

- X. The cards shall be capable of completing any write operation, even if the card is removed from the RF field during that operation.
- Y. The cards shall be warranted against defects in materials and workmanship for two (2) years.
- Z. The cards shall not carry any identification showing the location of the property unless otherwise specified herein and shall be guaranteed against the activation of any other card access system or anti-theft devices.
- AA. The cards shall be capable of accepting a slot punch on one (1) end, allowing it to be hung from a strap/clip in a vertical orientation.
- BB. One thousand (1000) Proximity iClass smart contactless access cards shall be provided by the vendor. The cards shall be compatible with the photo badging card printer such that cardholder images shall be printed directly onto the access card. Systems which utilize die cutters and lamination devices are unacceptable.
- CC. The Contractor shall provide two hundred (200) mobile card reader licenses.

2.8 ELECTRONIC LOCKS (BY DOOR HARDWARE)

- A. Electric locks shall provide free egress at all times. Authorized user entry shall be monitored via card reader. Request-to-exit shall be controlled by door lever.
- B. An electric door lock unit shall include electric power transfer and door loop as required. Contractor shall be responsible for coordinating with the door hardware division for installation, wiring and configuration requirements.
- C. In the event of a power failure or building down, electric lock equipped security doors shall fail secure unless otherwise noted.
- D. All electric locks shall have a minimum endurance of five hundred thousand (500,000) cycles.
- E. All electric locks shall be capable of supporting continuous duty to ensure that the locks remain unlocked for a programmable length of time without causing damage or failure to the electric lock.
- F. All electric locks shall be tamper resistant.
- G. The Security Contractor shall be responsible for coordinating with the door hardware division the installation, wiring and configuration requirements for the electric lock.

2.9 ELECTRIC STRIKES (BY DOOR HARDWARE)

- A. All electric strikes shall be capable of accepting both 12VDC and 24VDC, field selectable.
- B. In the event of a power failure or building down, electric strike equipped security doors shall fail secure unless otherwise noted.
- C. All electric strikes shall have a minimum static strength of one thousand and five hundred pounds (1500lbs).
- D. All electric strikes shall have a minimum endurance of five hundred thousand (500,000) cycles.
- E. All electric shall be capable of supporting continuous duty to ensure electric strikes remain unlocked for a programmable length of time without causing damage or failure to the electric strike due to heat.
- F. All electric strikes shall be tamper resistant.
- G. The Security Contractor shall be responsible for coordinating with the door hardware division for the installation, wiring and configuration requirements for the electric strike.

2.10 ELECTROMAGNETIC LOCKS (BY DOOR HARDWARE)

- A. The contractor shall be fully responsible to obtain a new magnetic lock permit as required. All fees for permits shall be included for.
- B. All electromagnetic locks shall have field selectable voltage, 12/24VDC.
- C. The following describes the performance capabilities for magnetic locks:
 - 1. An electromagnetic door lock shall consist of an electromagnet, door plate and control unit to provide a minimum sealing force of six thousand and six hundred (6600) Newtons (1500 pounds). Once the power is removed, residual magnetism will be no more than twenty (20) Newtons (5 pounds) for two hundred and fifty (250) ms and four (4) Newtons (2 pounds) after that.
 - 2. Door plates shall remain in full contact with the electromagnet at all times, even during a prying attack which distorts the door shape. No adjustments of the door plate should be required once it has been matched up with the magnet and installed.
- D. Each magnet shall be equipped with an indicator light to indicate secured or unsecured.
- E. Power requirements shall be matched to suit the system. Electromagnetic locks shall be powered from ULC listed electromagnetic lock power supplies provided by the security vendor. The system shall provide switching for the following:
- F. Lock/unlock under command: provide individual system command outputs which shall permit the system operator(s) to lock and unlock each individual maglock on an individual basis.
- G. All electromagnetic locks provided shall include a bond status switch indicating if the electromagnetic lock is locked (secure), unlocked (unsecure) or reduced holding force due to materials placed between magnet and plate. Electromagnetic lock shall send an alarm if these situations occur to the electromagnetic lock. Bond status switch shall not be used as a door status switch.
- H. Emergency release of the maglock power supplies will be initiated by the building fire alarm signal. Each maglock equipped door will have a DPST fire alarm pull station located within six hundred (600) mm. This station's second or third pole shall be interconnected to the maglock itself for emergency release. All fire alarm work is part of this contract.
- I. Fire alarm release: This contract will tie into the building required released mechanism and fully comply with the latest version of the O.B.C. and any authority having jurisdiction.
- J. A complete building maglock power supply riser shall be provided by the contractor. The contractor shall provide a set of relays on each floor (in a consistent electrical riser room) to allow for the local tie-in of future magnetic locks to the riser.
- K. The Security Contractor shall ensure that maglock riser interruption on any given floor will not cause all magnetic locks in the building to disengage. The failure shall result in the local floor magnetic lock fail safe procedures until a stage 2 fire alarm is realized.
- L. The Security Contractor shall provide a magnetic lock key-switch override located within the CACF room.
- M. The Security Contractor shall be responsible for coordinating with the door hardware division for the installation, wiring and configuration requirements for the electromagnetic lock.

2.11 CONCEALED DOOR POSITION SWITCHES/DOOR CONTACTS

- A. Door position switches shall be supplied and installed by the Door Hardware Contractor. Security Contractor shall be responsible for coordinating with the door hardware contractor for all installation, wiring and configuration requirements.
- B. Door position switches shall be of the 1", circular recessed type.

- C. All door position switches that are required to transmit signal to multiple systems shall be DPST.
- D. All exterior and perimeter door position switches shall have a minimum temperature range of -40oC to 65oC and have an IP 65 rating.

2.12 REQUEST-TO-EXIT MOTION DETECTORS

- A. Request-to-exit motion sensors are mounted directly above an electric strike door on the secure side. When it senses motion directly at the door, it shunts the door contact such that when the door is opened, an alarm is not generated.
- B. All request-to-exit motion detectors shall utilize infrared technology coupled with digital signal processing to prevent false alarms.
- C. The request-to-exit device shall also incorporate an integral local door alarm sounder independently controlled by the security DGP.
- D. All request-to-exit motion detectors shall contain a tamper switch.
- E. All request-to-exit motion detectors shall include LED indicator light to determine when motion detectors are active.
- F. All request-to-exit motion detectors shall be mounted in optimal position and properly aimed to site conditions.

2.13 REQUEST-TO-EXIT EGRESS BUTTONS

- A. The egress button assembly shall consist of a heavy-duty blue or yellow push button switch and stainless steel wall plate.
- B. The switch assemblies shall have sufficient "overplay" to be able to withstand repeated physical pressure.
- C. The switch shall be DPST type. One pole shall act as an egress input, while the second will interrupt power to the lock.
- D. The wall plate shall have the word "exit" engraved in it, in six (6) mm (1/4") high red letters and be designed to fit on a standard single gang electrical utility box.

2.14 HIGH SECURITY OVERRIDE

- A. All override/resets shall be tamper resistant key switches.
- B. All units shall be tamper resistant and installed with tamperproof screws.
- C. All units shall be constructed with minimum 1/4" extruded aluminum plate.
- D. All units shall be equipped with LED indication lamps indicating secure and unsecure.
- E. All units shall be equipped with screen printed reset/override and directional arrows indicating function of corresponding switches.
- F. Both override and reset switches shall have a switch configuration of SPDT to achieve momentary action.
- G. The Security Contractor shall provide a magnetic lock key switch override and reset switch in the building CACF room. The Security Contractor is fully responsible to ensure keyswitch is tied into the magnetic lock power supply riser.

2.15 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

- A. The Contractor shall be responsible for providing UPS units, appropriately sized to support the following rack mounted equipment for a minimum of one (1) hour:
 - 1. Security Workstations and Monitors

- B. The Communications Contractor shall be responsible for providing UPS units, appropriately sized to support the following rack mounted equipment:
 - 1. Access Control System primary and redundant servers
 - 2. Video Surveillance System primary and redundant servers
 - 3. Intercom System server/exchange unit
 - 4. Security Rack Mounted Equipment

2.16 BATTERY CONFIGURED POWER SUPPLIES

- A. Provide battery backup and associated power supplies for all field components with sufficient capacity to support the following security devices for a minimum of 4 (four) hours:
 - 1. Access Control DGPs.
 - 2. Electric door strikes and locks.
 - 3. Card Readers
 - 4. Request-to-Exit Devices
 - 5. Panic Buttons
 - 6. Duress Stations (audible and visual alarms)
- B. Power supplies are to be located within or wall mounted beside security DGPs as an integral part of the security system riser. All power supplies shall be mounted on minimum ¾" fire retardant plywood backboard.

2.17 ELECTROMAGNETIC LOCK POWER SUPPLIES

- A. Electromagnetic lock power supplies are to be located within or wall mounted beside security DGPs as an integral part of the security system riser.
- B. Electromagnetic lock power supplies are to be fed from GFCI circuits. Electromagnetic lock power supplies shall power only the electromagnetic locks.
- C. Emergency release of the maglock power supplies will be initiated by the building fire alarm signal. Each maglock equipped door will have a DPST fire alarm pull station located within six hundred (600) mm. This station's second or third pole shall be interconnected to the maglock itself for emergency release.
- D. Emergency release of the maglock power supply by means of a key operated release button/switch at the CACF room shall be installed by the Security Contractor. Security Contractor shall provide all required relays and tie-ins to base building maglock riser.
- E. A complete building maglock power supply riser shall be provided by the Security Contractor. The Security Contractor shall provide a set of relays on each floor (in a consistent electrical riser room) to allow for the local tie-in of future magnetic locks to the riser.
- F. Security Contractor shall ensure that maglock riser interruption on any given floor will not cause all magnetic locks in the building to disengage.
- G. Security Contractor shall provide a magnetic lock key-switch override located within the CACF room.
- H. All electromagnetic power supplies shall, at minimum, contain the following components:
 - 1. UL 294- UL Listed for Access Control System Units
 - 2. CUL Listed- CSA Standard C22.2.

2.18 UNIFIED SECURITY PLATFORM SOFTWARE, FUNCTIONS AND COMPATIBILITY

- A. The Security Management System (SMS) shall be an enterprise-level, powerful, flexible, multi-function and object-oriented security and event management system that features a variety of customizable interfaces for maintaining the system and for monitoring the desired secure sites. The SMS shall provide an option to display these management and monitoring interfaces in the

native languages of the people using the system. The security and event management system shall be flexible in order to meet specific requirements and quickly respond to evolving security challenges. The SMS shall be a scalable platform, simple and economical enough to support a single site, yet upgradeable enough to manage a multi-site network. The SMS shall use an open, distributed architecture, where database servers could reside in geographically separate locations.

- B. The SMS shall provide extensive information management capability using Microsoft .NET. It shall operate in a Client / Server configuration on personal computers with a Windows-based platform. Its distributed client-server architecture shall be capable of supporting minimum of 256 simultaneous clients, multiple types of controllers, and 10,000 input devices, including cameras and multiple types of card readers. The SMS shall be constructed to be database independent and shall support at a minimum Microsoft SQL Server 2005), for data protection, redundancy and manageability.
- C. The SMS shall have true multi-tasking, multiprocessor and remote client support; allowing independent activities and monitoring to occur simultaneously at different locations. The operator workstation (Client) shall be user-friendly, employing icon-based menus and providing a mouse-driven interface for system operation and the creation of colour graphic maps. The user interface shall be customizable, capable of delivering a unique look and feel without a unique version release. It shall be an intuitive user interface that is similar to Microsoft's Outlook and Explorer with its easy navigation and tree structures. A practical application layout editor shall let users drag and drop any application onto one screen and create a customized hub for all activities via a single "command and control" center.
- D. Field devices such as card readers, alarm inputs, control points, etc. shall be connected to fully distributed intelligent field controllers or directly through a Software Development Kit or Web Services, and be capable of operating without host computer intervention. All objects within the SMS, i.e. doors, readers, time intervals, etc. shall be addressed by a unique name as opposed to point numbering or mnemonics. The SMS shall have badge generation tools to create and manage badges using a graphical interface and convenient query features to manage large numbers of badges.
- E. The SMS shall be an integrated system that utilizes a single, industry-standard relational database management system for the storage and manipulation of related data. The SMS shall include a server with operating system and applications software, operator and administrator terminals with appropriate software, hard copy printers and fixed magnetic storage media. The security devices shall communicate with the field panels via a dedicated cable network. The field panels shall communicate to the server via a Fast Ethernet 10/100, TCP/IP network connection.
- F. The SMS shall allow for growth and scalability from a low-end or entry level system to a high end or enterprise system by increasing CPU power, memory and database. The SMS shall be modular in nature, allowing system capacities to be easily expanded without requiring major changes to system operation. All defined system data as well as historical information shall be maintained. Customizable user interfaces shall allow management of system information and activity for administrators and operators. The SMS shall include an intuitive .NET based badging solution with a badge layout editor and GUI for badge design.
- G. SMS Functionality
 - 1. Partitioning
 - a. The SMS shall allow system administrators to separate the creation and viewing of objects into partitions. SMS operators shall be associated with partitions and this shall determine which objects operators have the ability to create and or view. The SMS shall support an unlimited number of partitions.
 - b. The SMS partitions shall include but not be limited to the following objects:

- 1) Personnel
 - 2) Clearances
 - 3) Doors
 - 4) Controllers with all associated hardware (readers, inputs, outputs, etc)
2. Through the use of privileges, the SMS System Administrator shall be able to determine which objects are associated with a particular partition. These objects shall then be assigned to System Operators with the appropriate privilege.
3. The SMS shall support a super-user assigned the 'System All' privilege who shall have full access to all objects in all partitions.
4. Any operator shall have the ability to be assigned access rights to any partition. Individual Access rights shall be created and have the ability to be assigned to any users of the SMS.

H. Administration Operator Interface

1. The SMS shall employ an Administration Operator Interface to control the following:
 - a. Hardware (readers, inputs, outputs, video systems, door controls, CCTV, and other systems).
 - b. Configuration of personnel records, operators and operator privileges.
 - c. Graphical Maps.
 - d. Application Layouts.
 - e. Dynamic Views.
 - f. Queries.
 - g. Import/Export of objects, including images.
 - h. System Variables.
 - i. Reports (either periodic or one-time).
 - j. System functions (event command and control, actions, schedules).
 - k. Display of a list of objects in a grid that can have their values modified and respond to real-time status changes.
 - l. Scheduling of backups.
 - m. Monitoring of system settings and performance.
 - n. Designing of and printing of badges.
 - o. The GUI shall be configurable by the system administrator to control the views and access of each Monitoring Station operator.

I. Monitoring Operator Interface / Activity Monitoring

1. The SMS shall contain a monitoring component that is capable of, among other things, displaying the current state of any object in the system. Additionally the monitoring station shall be capable of displaying a log of all activity that occurs in the system, from object state changes, to access control information. All text for events (alarms) in the system shall be configurable to be displayed in colour based on the user-specified priority of the event.
2. The Monitoring Station shall be capable of showing all changes occurring to an object without requiring the associated activity messages for that object to be routed to that monitoring station. The SMS shall require the operator to have appropriate permissions to view and/or control any object.
3. The monitoring station interface shall be user-customizable. The SMS shall support the ability of the end user to create a customized application layout for the monitoring station. The monitoring station shall support multiple application layouts that can be assigned to the operators. Each application layout can have multiple panes in the same window. The panes can have multiple tabs so that different objects such as cameras and tours can be displayed in the same pane. The panes shall have the ability to include: General activity; Event (Alarm) activity; Dynamic card swipe information; Video cameras and tours; Maps; Dynamic Views; Reports; and links to external applications. Each pane shall have the ability to be moved to a specific screen.
4. The SMS shall provide the Monitoring Operator with a minimum of the following functional capabilities:

- a. Shall provide a scrolling list of lines or tiles showing current activity on the system.
 - b. Shall display activity in real-time as data is being transmitted by field hardware.
 - c. Shall include icons that indicate the type of activity and textual description of the activity.
 - d. A series of menus, driven by drop-down or trees, shall allow the Monitoring Station operator to perform manual actions, such as "momentary door unlock" for a given door.
 - e. As part of the manual action capability, the system shall provide screens or boxes that query the operator on specifics, such as start and end time, and offer guidance on performing the manual actions.
 - f. A GUI that displays the images of personnel as they enter, as well as the stored images of personnel available in the SMS.
 - g. Ability to view a sortable list of active alarms or events and recently active alarms or activity.
5. The SMS shall support audible alarm annunciation at operator workstations.
 6. The activity monitoring screen shall be capable of displaying the minimum features including, but not limited to the following:
 - a. System clock.
 - b. Date/time when the activity actually occurred and the date/time when the activity was received by the server shall be displayed (when they are different).
 - c. Real time event counters.
 - d. Count of the active events.
 - e. Count of the events requiring operator acknowledgment.
 - f. Name of operator logged on at the workstation.

J. Web Client

1. The SMS shall support a Thin Client to provide remote access to the SMS Server via a web browser. The Thin Client shall support Microsoft® Internet Explorer 7.0 and Mozilla Firefox® 3.0 or greater.
2. The Thin Client shall support Single Sign-on utilizing Windows Authentication. The privileges of the SMS operator shall be propagated to the Thin Client User allowing only access to Security Objects for which the SMS Operator is authorized. The Thin Client shall provide support for Partitioning of the system and utilize the Partitions assigned to the Operator.
3. All changes made to the SMS database via the Thin Client shall be recorded in the Audit Trail Database.
4. The Thin Client shall provide Personnel Management, allowing the Operator to create and modify Personnel data (includes adding/removing clearances, schedules, and expiration dates). The Operator shall have the ability to enable and disable cards. The Operator shall have the ability to search for, edit, add, and delete Personnel records from the SMS database. The search function shall allow wildcards and shall include First name, Last name, card number, and user defined text 1.
5. The Thin Client shall support Manual Actions to include the Locking/unlocking of doors, and the Activation/deactivation of events.
6. The Thin Client shall support the display of Dynamic Views as defined by the SMS. Dynamic Views shall provide a real time view of SMS data including Journal and Audit Trail history. Viewing of Multiple Dynamic Views shall be supported.
7. The Thin Client shall support creating, configuring, loading and saving of reports. Reports shall consist of personnel history activity or audit data. The report data shall allow sorting within the thin Client view page by any displayed field in ascending or descending order. The Thin Client shall allow reports to be saved in the following formats: XLS, CSV, XML, TXT or PDF. The operator shall have the option to save the report to a file or send it via email.

K. Graphic Maps

1. The SMS shall support unlimited graphic maps and icons to be displayed on the operator workstation monitor.
2. The system shall support an operator-programmable, colour graphic map display that:
 - a. Shall be capable of showing the floor plan, the location of alarm devices, and alarm instructions for a facility.
 - b. Shall be centralized in the system configuration and displayed on the operators' workstations.
 - c. Shall allow various maps to be associated with different areas to create a hierarchy of maps.
 - d. Shall support graphic maps having a minimum resolution of 1024x768 Pixels.
3. Operators shall be able to use drag-and-drop mouse technique to place dynamic system level object icons of all objects such as: cameras, video servers, inputs/outputs, events, maps, reports, dynamic views, and door/elevator icons. These dynamic object icons shall allow a system operator to perform tasks and issue commands related to the object by double-clicking on the icon.
4. The SMS shall be able to directly import the following file formats for the map:
 - a. AutoCAD (.DWG)
 - b. SVG
 - c. DXF
 - d. DWF
 - e. Windows Meta File (WMF)
 - f. TIFF (.TIF)
 - g. JPEG (.JPG)
 - h. PNG
 - i. Windows Bitmap (.BMP)
5. The Maps feature shall include two operational modes: an administrative mode to allow configuring of the facility floor plans or site plans that show exterior features and a runtime mode to allow monitoring and interacting with the configured facility layouts or site plans. The Maps feature shall also include a tracking window, a magnification window, and a coordinates window.

L. Information Storage, Backup and Transfer

1. All programmed information, as well as transactional history, shall be automatically stored in the database for later retrieval and backup. The SMS shall support configurations where the SMS database(s) may be installed on a hard drive on the SMS server, on an independent database server, or in an existing corporate database server.
2. The SMS shall be capable of backing up and restoring all system data and transactional history. The server shall be capable of transferring all programmed data and transactional history to CD-ROM, DVD, or Hard Drive (including networked drives).
3. The SMS shall allow activity history to be written to a database. The system shall have the capacity to store a minimum of 50 million transactions. There shall be a method of backing up the activity history on external media and then restoring and replaying it.
4. The SMS shall support 256-bit encrypted communications between server and user client.
5. The SMS shall support 256-bit encrypted communications between server and controller. The encryption shall support both local and third-party digital certificates.

M. Communication Ports

1. The SMS shall be able to support multiple serial devices. In addition to COM1 and COM2, up to 8, 16, 32, to 256 additional ports may be configured through the use of a port expander or its equivalent. These serial ports may be used for connection to CCTV matrix switchers, or additional panels.

2. The SMS shall support the use of Ethernet networks as the communications path between the host computer and field devices. This communications path shall be the same network used for communications between the host server and the operator workstations. The communications between the host computer and the field devices shall be encapsulated in a TCP/IP network/transport layer.

N. Printers

1. The SMS shall support report printing. The report printer(s) may be connected directly to the client PC or shared over a network. The SMS shall support as report printer(s) any printer for which a printer driver exists within the Windows XP, Windows Vista, Windows 7, Windows 8, Windows Server 2003, or Windows Server 2008 operating systems.

O. Software Configuration

1. The SMS configuration tools shall utilize intelligent configuration controls. The system shall be structured so an operator is unable to perform configuration functions that are invalid based on the configuration used. The system shall support the ability to search within browser lists using filtering operators such as "begins with", "ends with", "contains", etc. The system shall also allow an operator to do searches using filtering operators on any class of object in the system, both in the Administration application and the Monitoring Station application.
2. The SMS shall allow text description of all configured objects. The SMS shall allow the renaming of an existing title description without removing the sub-components of that configuration object. The SMS shall automatically remove from the system all configuration references to an object being deleted. The SMS shall automatically provide default names for all inputs, outputs, readers, and extension boards. The SMS shall clearly display which hardware objects (inputs, outputs, readers) on a controller are configured, and which are not.

P. Personnel Records

1. The SMS Personnel records shall provide multiple tabbed pages of personnel data containing default system and user-defined fields. The SMS shall support an unlimited number of tabs allowing an unlimited number of user-defined fields. Labels for user-defined field tabs shall be customizable by the System Administrator with the appropriate privileges. Each user-defined field shall allow a name, description and label. A default language shall be selectable by the System Administrator for the user-defined field labels.
2. User-defined fields shall be definable as Mandatory or Unique and shall support, at minimum the following field types:
 - a. Character
 - b. Integer
 - c. Logical
 - d. Date/Time
 - e. Date
 - f. Time
 - g. Enumerated List
 - h. Multi Line
 - i. Decimal

Q. Inputs

1. The SMS shall monitor both supervised and unsupervised hardware inputs as well as virtual inputs such as predefined system messages. These inputs include door / elevator inputs and monitor points. The SMS shall also monitor controller inputs such as tamper, AC fail, and low battery.
2. The SMS shall have the ability to name and allow for user-defined descriptions for individual inputs, outputs, and readers as well as input and output modules.

R. Card and Reader Support

1. The SMS shall be designed to support multiple card formats and card reader types.
2. The SMS shall support the following features for directly connected readers:
 - a. User defined card formats up to 256 bits.
 - b. Unlimited number of SMS card formats.
 - c. The ability to assign up to 10 card formats per reader.
 - d. The ability to show reader status on reader controller LCD.
 - e. Support Wiegand and 3x4 matrix keypads.
 - f. The enrollment of biometric templates to smartcards.

S. Door Configurations

1. The SMS shall allow doors to be configured to operate in any of the following access control modes:
 - a. Unlocked
 - b. No Access (Secure mode)
 - c. Any combination of the following, as defined by schedule, event card only, PIN only, Card + PIN, Card entry through keypad.
2. The SMS shall allow a door to be configured to operate using the following functions:
 - a. Readers shall read cards while the door is in the open position.
 - b. Door lock relay shall automatically lock upon the door being opened.
 - c. Allow for a user-defined delay relock time period.
 - d. Allow for a user-defined door unlock time and door held open time.
 - e. A separate (alternate) shunt timer for ADA flagged cardholders
 - f. The operator shall be able to specify a shunt expiration output to be triggered for a configurable time (in hh:mm:ss) before the expiration of the door open or alternate shunt. Can be enabled for ADA only, or all the time.
 - g. Allow for a user-defined door unlock and door held time, in seconds.
 - h. PIN-only access (keypad).
 - i. PIN-entry on the reader keypad shall be required during a specified schedule after a card access (unless a manual action or event has disabled PIN).
 - j. Card entry through keypad.
3. The SMS shall allow each door to be configured to cause a variety of events such as alarms to occur based on activity at that door.
 - a. The SMS shall support configuration of unlimited elevators.

T. Area Control and Antipassback

1. The SMS shall support the ability to define Area configurations. Areas are defined as physical regions bounded by doors. An area shall consist of a room, a specific location(s) within a building, or an entire building.
2. All configured areas shall have in/out access doors providing the ability to run reports showing all present cardholders in each area. There shall be no way to leave an area without presenting a credential to a reader/door.
3. The SMS shall provide the ability to run a Roll Call report. The host shall maintain a current area for each personnel record, and the time at which the area was entered (AreaAccessTime). The current area shall represent the last area entered by the cardholder based on a valid admit.
4. The SMS shall support Area control to provide the ability for tracking personnel. With this function, an operator shall obtain the current location of cardholders. Dynamic views and or reports can be generated to show specific cardholders who are present in each defined area.
5. The SMS Area configuration shall have three modes of operations: None, Antipassback, and Timed Antipassback.

6. Antipassback shall control access based on the cardholder's location. The SMS shall deny access to cardholders who are in violation of antipassback rules. In the event that a cardholder leaves an area without presenting their credential to the out access reader/door and then tries to enter back into the area by swiping the In access reader/door, a denial of access will occur. The SMS system shall provide the ability to grace individual cardholders who have violated antipassback rules. The Grace option shall also provide the ability to grace all cardholders.
7. Antipassback shall continue to be enforced during communications failure. SMS controllers shall have the ability to be clusters in a group. The main controller in the group and all other controllers within that group shall have full access to the existing antipassback information. The cluster can be configured for 'No Access' Communications Failure mode or for 'Local' Communications Failure mode.
8. Clustered controllers configured in 'Local' mode that are disconnected from the main controller shall grace all cardholders from antipassback violations. The disconnected controller shall then follow antipassback rules specific to the areas defined on that controller. If the controller does not know if a cardholder is in antipassback violation based on areas that are configured between controllers, access will be granted.
9. Clustered controllers configured in 'No Access' mode that are disconnected from the main controller mode shall not grace all cardholders from antipassback violations. All cardholders will receive a denial of access until communications is restored.
10. The SMS shall support Timed Antipassback. Areas configured for Timed Antipassback shall require a cardholder use an exit reader to exit an area. Cardholders who do not exit properly shall be required to wait for a predetermined period of time before re-entering the area.

U. Schedules

1. The SMS shall support unlimited operator configurable schedules. Each schedule shall allow unlimited individual time intervals.
2. Each system controller shall support a minimum of 128 schedules and a minimum of

V. Events

1. The SMS shall support unlimited operator configurable events, including the scheduling of events, and action-based trigger of events.
2. The system shall provide 8 configurable event priority levels with a total of 200 numbered event priorities. The system shall allow the operator to define custom colours and labels per individual priority level.
3. The system shall allow an event to be configured to:
 - a. Be sortable by event name, date/time, priority, state, and any other displayable information.
 - b. Be routed to operators by operator privileges, including support for the routing by time of day feature.
 - c. Require or not require operator acknowledgment.
 - d. Require or not require a log message to be entered by the system operator responding to the event.

W. Import / Export

1. The SMS shall provide a means for manually importing and exporting selected data in XML format. This mechanism shall support the import and export of any and all classes or types of data in the system. Specific data validation and logging requirements shall be met.
2. The system shall also support importing from CSV files.
3. The SMS shall provide an automated import mechanism (preferably XML-based). This mechanism shall support the import of most classes or types of data into the system. Specific data validation and logging requirements shall be met.

4. The SMS shall provide a Data Mapping feature that provides field mapping information using the XSLT file based on the input data or an external XSLT file.
- X. Objects
1. Each object within the SMS shall be addressed by a unique operator-defined name. Object names shall be unique within object types.
 2. The SMS shall provide the ability to add description text to each object definition.
- Y. Reports
1. The SMS shall provide configurable data reports for database configuration, historical activity (Journal) and audit tracking. Pre-defined reports shall be available for download and import into the system.
 2. The SMS report function shall perform the following:
 - a. Create reports about any object.
 - b. Create report templates to simplify report design.
 - c. Run reports on demand.
 - d. Save report results for sharing between different users of the application.
 - e. Export reports into formats such as PDF, RTF, TXT, TIFF, Excel (XLS), and MHTML.
 - f. Specify a query to select and filter the records on which to report.
- Z. Dynamic Views
1. The system shall support a grid format displayable report that will be usable to display homogeneous lists of objects within the system. This display shall be configurable both at configuration time and also at run time.
 2. The Dynamic views shall have the following features:
 - a. Real-time updating and display of property values.
 - b. The display shall be sortable.
 - c. Groupable by any number of columns.
 - d. Filterable based on user selectable criteria.
 - e. Printable.
- AA. Photo Badging Subsystem
1. The SMS shall utilize the photo-badging workstation. The photo-badging workstation shall consist of a photo-badging printer, digital high-definition camera for capturing credential holder images and a desktop workstation with LCD monitor, keyboard and mouse.
- BB. Server Requirements
1. All SMS servers shall comply with the minimum specifications stated below:
 - a. Intel Quad Core Processor (3.2 GHz or better)
 - b. Dual 10/100/1000 NICS
 - c. 8 GB DDR2 667MHz
 - d. 1TB GB HDD at 7200RPM
 - e. CD/DVD-RW combo drive
 - f. Windows based
 - g. IIS 7.0 or better
 - h. SQL Server 2020
 - i. 20" or larger 1080p LCD monitor
 - j. 1 GB SVGA video card with at least 128 MB onboard RAM
 2. The ACAM server provided shall be complete with all required software, licensing and network configuration for a fully functional system.
 3. All SMS client workstations PC shall comply with the minimum specifications stated below:
 - a. Intel Dual Core 3.2 GHz Processor
 - b. Dual 10/100 NICS

- c. 4 GB RAM
- d. 500 GB HDD at 7200 RPM
- e. Quad Video Outputs.
- f. 1080p LCD Monitors (quantity and size as stated on the drawings)
- g. 2GB Radeon Video Card
- h. CD/DVD-RW combo drive
- i. Windows Based
- j. Keyboard
- k. Optical Mouse
- l. PTZ Joystick Controller (for the Video Surveillance System)

CC. Clustering

1. The SMS shall support a user-defined grouping of controllers defined as a cluster. Controllers within a cluster shall be able to communicate in a peer-to-peer scheme should the SMS server lose communication with the cluster.
2. Clustering shall support the following features:
3. Assignment of main and alternate main controllers for cluster communication to the SMS server
4. Primary and backup communication paths to the SMS server
5. Encrypted communications
6. Up to 16 controllers per cluster
7. Logical event linking between controllers in a cluster independent of SMS server communication.
8. Asynchronous communication via TCP/IP (Polled devices shall not be acceptable).

2.19 SECURITY DOOR FUNCTIONALITY AND OPERATION

A. General

1. The following section describes the physical characteristics, operational modes and corresponding implementation methods for the access control and alarm monitoring applications required.
2. The contractor shall ensure the desired operations are adhered too but is not limited to the descriptions provided below.
3. The contractor is to work in conjunction with the Owner or Owner appointed project manager in order to make certain all access control applications are properly instituted, programmed and corresponds with the Owners expectations.
4. The contractor shall provide all necessary inputs, outputs, devices, software and associated matter to accommodate and deliver all access control applications in proper working order.

B. Supervised Access

1. A supervised or monitored access point is typically secured with mechanical key operated locks and not equipped with access control card readers or user specific requirements. Through the use of door position switches, the access control system shall determine the state of the door in terms of open, closed or forced.

Mode of Operation	Corresponding I/Os
Normal	if DPS = 0 then intrusion = 0
Access	if access = 1 then inhibit alarm reporting
Intrusion	if DPS = 1 then intrusion = 1

2. The associated security drawings will indicate the locations of supervised doors based on the corresponding devices.

3. Security doors with multiple leaves and therefore multiple door position switches, shall be fused via a junction box to ensure the access control system views them as one (1) door.
4. The contractor shall provide an end of line resistor allowing the access control and alarm monitoring system to supervise the wiring between the door position switch and data gathering panel.

C. Controlled Access

1. A controlled access point is typically secured with electromagnetic locks and bond sensors and not equipped with access control card readers or user specific requirements. The access control system is used to energize or de-energize the electromagnetic locks and determine, via the bond sensor, if the door is magnetically secured. Furthermore, the access control system shall determine the state of the door in terms of open, closed or forced.

Mode of Operation	Corresponding I/Os
Normal	Owner Defined
Access	if access = 1 then inhibit alarm reporting and de-energize maglock
Intrusion	if DPS = 1 and access = 0 then intrusion = 1
Closed	if DPS = 0 then set closed mode
Open	if DPS = 1 and intrusion = 0 then set open mode
Secure	if bond sensor = 1 and DPS = 0 then set secure mode
Not Secure	if bond sensor = 0 then set not secure mode
Key Reset	if pushbar keyswitch = 1 then set normal mode
Lockout	if lockout = 1 then cancel and disable access function
Pullstation	if pullstation = 1 then set fire pullstation mode

2. The associated security drawings will indicate the locations of controlled doors based on the corresponding devices.
3. Security doors with multiple leaves and therefore multiple door position switches, maglocks and bond sensors shall be fused via a junction box to ensure the access control system views them as one (1) door.
4. The contractor shall provide an end of line resistor allowing the access control and alarm monitoring system to supervise the wiring between the door position switch and data gathering panel.
5. The contractor shall provide twelve (12) VDC power from a security DGP location to each device under this contract, whether or not the devices were supplied by the contractor.
6. The contractor shall integrate the electromagnetic lock with fire alarm system devices in order to ensure that the lock will become de-energized in the event that a fire alarm is realized. The fire alarm contractor shall provide cabling from the fire alarm DGP to the door site.

D. Access Control

1. Access controlled security doors are typically secured with card readers, electromagnetic or electric strikes/locks, door position switches, bond sensors (if applicable) and a request to exit in the form of either a motion detector, pushbutton or handle / pushbar.
2. Access controlled doors may be incorporated into free egress fire exit routes. The contractor shall provide the necessary features and applications associated with free egress fire routes and doors.

Mode of Operation	Corresponding I/Os
Normal	Owner Defined
Access	if access = 1 then inhibit alarm reporting and release maglock and door handle
Intrusion	if DPS = 1 and access = 0 then intrusion = 1 and energize horn/strobe
Closed	if DPS = 0 then set closed mode
Open	if DPS = 1 and intrusion = 0 then set open mode
Secure	if bond sensor = 1 and DPS = 0 then set secure mode
Not Secure	if bond sensor = 0 then set not secure mode
Key Reset	if pushbar key switch = 1 then set normal mode
Lockout	if lockout = 1 then cancel and disable access function
Pullstation	if pullstation = 1 then set fire pullstation mode

3. The associated security drawings will indicate the locations of primary security line doors based on the corresponding devices.
4. Security doors with multiple leaves and therefore multiple door position switches, maglocks and bond sensors shall be fused via a junction box to ensure the access control system views them as one (1) door.
5. The contractor shall provide an end of line resistor allowing the access control and alarm monitoring system to supervise the wiring between the door position switch and data gathering panel.
6. The contractor shall provide twelve (12) VDC power from a security DGP location to each device, whether or not the devices were supplied by the contractor.
7. The contractor shall integrate the electromagnetic lock (if applicable) with fire alarm system devices in order to ensure that the lock will become de-energized in the event that a fire alarm is realized. The fire alarm contractor shall provide cabling from the fire alarm DGP to the door site.

E. Fire Egress

1. Doors that provide fire egress are equipped with devices that may include wired hinge, panic bar, and timing device that provides a fire code compliant unlocking delay.
2. At each electromagnetically locked fire egress door there will also be a fire alarm system pullstation and a fire alarm lock release relay provided by others.
3. Fire alarm equipment is supplied and installed by others.

4. The contractor shall provide and connect an access control panel input to the fire alarm pullstations and to the exit delay timer relay output such that each door pullstation/exit delay timer is represented by a unique point in the access control system.
5. The contractor shall incorporate the fire egress and fire alarm devices into the access control hardware, software, drawings, documents and all other requirements of this RFP.

Mode of Operation	Corresponding I/O's
Normal	Owner Defined
Fire Release	if fire alarm system control relay = 1 and BS = 0 then set fire release mode
Pullstation	if pullstation = 1 or EDT = 1 then set fire pullstation mode

F. Lockdown Programming

1. Lockdown programming is based upon the event-initiated program capability of the access control system servers and data gathering panels.
2. When the event-initiated program trigger point is in an access control panel and all of the required output control points are in the same panel, the panel shall execute an internal event-initiated program to satisfy the requirements of this application.
3. Lockout, in this application refers to, close, lock, and monitor the door, and disable the card reader.
4. An authorized access control system operator shall be able to selectively command any door in a lockdown mode to timed access mode.
5. When an event-initiated program contains outputs in multiple data gathering panels, the event-initiated program shall use the access control system servers to issue control commands to all other DGPs.
6. The lockdown programming shall include the following event-initiated program sequences:
 - a. Primary Security Lockdown – Triggered by an access control system command. All primary security lines are locked down.
 - b. Building Exterior Lockdown – Triggered by an access control system command. All building exterior doors are locked down on the public side.
 - c. Building Interior Lockdown – Triggered by an access control system command. All interior building doors are locked down and card readers disabled.

2.20 PANIC ALERT SYSTEM

- A. Provide a fully integrated hardwired Panic Alert System. Panic alarm stations to be supplied and installed at locations as indicated on drawings.
- B. Each hardwired panic alarm station shall:
 1. Be desk, surface or wall mountable.
 2. Not be larger than 2.5" W x 2.5" L x 1.5" H.
 3. Have gold cross-point contacts, brass terminals, stainless steel spring, thermoplastic case and button and copper alloy blades.
 4. The pushbutton shall be recessed into the casing to avoid accidental alarm.
- C. Sequence of Operation:
 1. Each panic button shall be monitored via an alarm input on the associated DGP with monitoring at the SMS workstation(s).
 2. Activation of a panic station/button shall result in an alarm which will be displayed and recorded at the SMS workstation(s).

3. Security Contractor shall supply a sample of a panic station c/w the custom designed enclosure to the Architect for review prior to installation.
- D. Panic Alert System Universal Washroom Panic Strip Device (Supplied and Installed by Contractor. Contractor to provide connection and termination from device to Security DGP):
 1. Ontario Accessibility Standards shall govern the installation of barrier-free hardware.
 2. Be a composite construction with built-in continuous pressure welded copper contacts that will have an air gap between the two contacts of no more than 5.0mm.
 3. Be comprised of a two part composite construction that is continuously welded together and acts as an enclosed switch along the length of the activation zone.
 4. Have a normally open, momentary-contact pressure switch with a maximum active zone width of 34mm wide and will allow for any impact made at any angle, anywhere across the length and width of the pressure switch to activate the alarm.
 5. Be rated for a minimum of 1 Amps at 24 Volts AC or DC.
 6. Have a tamper resistant design.
 7. Be designed to provide high visibility.
 8. Be available in custom colours and labels.
 9. Sequence of Operation:
 - a. Each panic strip shall be monitored via an alarm input on the associated DGP with monitoring at a Security system workstation(s).
 - b. Activation of a panic strip shall result in an alarm which will be displayed and recorded at a Security system workstation(s).
 - c. Contractor shall supply a sample of a panic strip c/w the custom designed enclosure to the Architect for review prior to installation. Coordinate exact mounting location with the Architect.

2.21 NETWORK VIDEO MANAGEMENT SYSTEM (NVMS)

- A. The video surveillance system shall be an extension of the existing Genetec based video surveillance system currently existing on site.
- B. The NVMS shall be a highly scalable enterprise level software solution.
- C. The contractor shall be responsible for providing all NVMS modules and licenses required to provide a fully functional system.
- D. The NVMS shall be installed on hardware which meets or exceed the manufacturer's recommended requirements.
- E. The design and performance requirements for the NVMS software are as follows:
 1. The live output from cameras shall be viewed through a series of displays. These shall support:
 - a. Single camera view
 - b. Quad view of up to four cameras
 - c. Sequence view of camera preset positions
 - d. Modifying settings for a camera
 - e. Modify recording settings for a camera.
 - f. Adding and deleting cameras
 - g. Creating schedules for recordings and video motion detection
 - h. Modifying Video Motion Detection settings and tuning
 - i. Users shall be able to select a camera from a tree control listing the cameras available to the user.
 2. The system shall also support multiple monitors in the following way:

- a. Alarm monitor: When an alarm occurs in the Security Management System Server, the live video output of the camera associated with that alarm shall be switched directly to an alarm monitor. The user shall be able to acknowledge the alarm to clear the monitor using the numeric keypad.
 - b. Surveillance monitor: Operators shall be able to send any Quad View, Sequence View or Single Camera View to a surveillance monitor. User shall be able to clear the monitor using the numeric keypad.
 - c. Monitors shall be able to be configured to act as both Alarm and Surveillance monitors. In this case, the monitor behaves as a Surveillance monitor until an alarm occurs, in which case it shall show the alarm video. Once the alarm is acknowledged, the video previously shown (as a surveillance monitor) is displayed again.
 - d. In each of these cases, these additional monitors shall be either connected to a Security/Digital Video Workstation using a multi-monitor PC card or to other PCs.
3. From single camera display, the user shall be able to:
 - a. View the live output from the selected camera.
 - b. Pan, tilt, zoom and focus the camera using a joystick attached to the Security/Digital Video Workstation PC.
 - c. Pan, tilt, zoom and focus the camera using a pointing device attached to the Security/Digital Video Workstation PC; devices such as a mouse or touch-screen shall be supported.
 - d. For cameras which support continuous pan, tilt, zoom (PTZ), a mouse shall be able to be used for continuous PTZ directly in the live video window. By dragging the mouse up or down, left or right in the video window, the operator shall be able to tilt the camera up or down, or pan the camera left or right. Zooming must also be provided using the mouse in a similar way.
 - e. Users shall be able to change important settings for an individual camera. The details are grouped into several sections:
 - 1) Camera Details
 - 2) Camera Connection
 - 3) Camera PTZ Control
 - 4) Security
 - 5) Camera Deletion
 - 6) Only users with the highest level of security are permitted to modify camera connection details, camera PTZ control or delete cameras.
4. The user shall be able to configure the following parameters for each camera:
 - a. Name
 - b. Location
 - c. Description
 - d. Camera Number (for fast numeric keypad call-up)
5. The user shall be able to configure the following parameters for each camera:
 - a. Camera Streamer Type
 - b. Resolution
6. Video Frame Rate: The supported frame rates (in frames per second) shall be as follows:
 - a. For Motion JPEG encoding: 30, 25, 20, 15, 10, 5, 3, 2 and 1. Slower frame rates of 1 frame every 2, 3, 5, or 10 seconds shall also be available.
 - b. For MPEG encoding: 30, 25, 15, 12.5, 7.5, 6.25, 3.75 and 1
 - c. Choice of five levels of video compression, equally distributed from minimum to maximum compression.
 - d. Streamer IP Address
 - e. Streamer Camera Number (when connected to a multiple port Camera Streamer)
 - f. Choice of frame rate or bandwidth limited streaming

- g. Unicast or multicast transmission of video.
- h. NTSC camera format
- 7. The following PTZ characteristics shall be tuneable on a camera-by-camera basis from the camera definition pages:
 - a. Pan speed
 - b. Tilt Speed
 - c. Zoom speed
 - d. Focus speed.
 - e. Iris speed
 - f. Increment step size
- 8. The following methods of recording live video shall be supported:
 - a. User activated.
 - b. Event activated.
 - c. Scheduled
 - d. Video motion detection
 - 1) Snapshot
- 9. The user shall be able to configure the following parameters for each camera:
 - a. Pre-Record Duration: The amount of pre-recorded video that will be associated with a user request for recorded video. This will allow the Camera Server to capture video prior to the user request, as well as after the request. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes.
 - b. Frame Rate: Video quality required for user activated recording. It shall be possible to have different frame rates for user and event-activated recordings. Shall be selectable from the entire range of frame rates supported for the camera. For MPEG encoding, support shall be provided to record only the Index frames, or a subset of the Index frames.
 - c. Record Duration: User activated recordings shall terminate after this period. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes.
 - d. Retention Period: The default period that the Camera Server shall retain user-activated recordings before being deleted. The retention period of individual recordings shall be able to be changed on a per-recording basis. Shall be selectable from a list of values ranging between one hour and forever.
- 10. There shall be at least four priorities of alarms/events in the Security Management System
- 11. The following settings shall be individually configurable for each alarm and each camera:
 - a. Pre-Record Duration: The amount of pre-recorded video that will be associated with an alarm/event. This shall allow the Camera Server to capture video prior to the alarm/event, as well as after the alarm/event. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes.
 - b. Post Record Duration: Event activated recordings shall terminate after this period. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes
 - c. Frame Rate: Video quality required for event activated recording. It shall be possible to have different frame rates for user, event-activated, scheduled and motion detection activated recordings. Shall be selectable from the entire range of frame rates supported for the camera/streamer. For MPEG encoding, support shall be provided to record only the Index frames, or a subset of the Index frames.
 - d. Retention period: The default period the Camera Server will retain event-activated recordings before being deleted. The retention period of individual recordings shall be able to be changed as necessary. Shall be selectable from a list of values ranging between one hour and forever.
- 12. The system shall support the ability to schedule recordings for each individual camera for times in the future. For each scheduled recording the user shall be able to configure:
 - a. Start time.
 - b. Stop time.

- c. Frame rate for the recording
 - d. Retention period before the recording will be deleted.
 - e. Recurrence (if this is to be a recurring schedule)
- 13. The NVMS system must be able to activate recordings automatically when motion is detected on any cameras that have video motion detection enabled. The enabling of video motion detection shall be either:
 - a. On a continuous basis or
 - b. Scheduled for particular times, dates, days, months etc.
- 14. The NVMS system must be able to support video motion detection algorithms, which can be executed by the video streamer or the Camera Server. The Camera Server-based algorithm must be able to provide the following functionality:
 - a. Detect and track objects.
 - b. Learn the scene.
 - c. Adapt to a changing outdoor environment.
- 15. The user shall be able to configure the following parameters for each camera:
 - a. Detection Type: Continuous or scheduled.
 - b. Actions to Perform When Motion is detected: When motion is detected, the following actions shall be performed automatically.
 - c. Generate an alarm in the Security Management System of configurable priority (journal, low, medium, high)
- 16. Start a recording, with the following configurable settings:
 - a. Pre-Record Duration: The amount of pre-recorded video, allowing the Camera Server to capture video prior to the detection of motion, as well as after the detection of motion. Shall be selectable from a list of values ranging between zero (0) seconds and five (5) minutes.
 - b. Post Record Duration: Motion detection activated recordings will terminate after this period. Shall be selectable from a list of values ranging between 0 seconds and 5 minutes or until motion has stopped.
 - c. Frame Rate: Video quality required for motion detection activated recordings. Shall be selectable from the entire range of frame rates supported for the camera/streamer. For MPEG encoding, support shall be provided to record only the Index frames, or a subset of the Index frames.
 - d. Retention period: The default period that motion detection activated recordings will be retained by the Camera Server before being deleted. The retention period of individual recordings shall be able to be changed as necessary. Shall be selectable from a list of values ranging between one hour and forever.
 - e. Send video to a Security/Digital Video Workstation or alarm monitor: Automatically switch a Security/Digital Video Workstation or alarm monitor to view the camera which has motion detected.
- 17. The NVMS must provide a means of automatic and manual tuning of the Video Motion Detection for each camera. Incorporated within this tuning are the following:
 - a. Selection of the frame rate used for detection.
 - b. Optimization for directions of movement
 - c. In any direction
 - d. Across the camera view
 - e. Towards and away from the camera
 - f. Sensitivity level to fine tune the motion detection algorithm
 - g. The NVMS must also provide the ability to only detect motion in particular regions of the camera view. The ability to graphically select these regions using the mouse must be provided, with an unlimited number of regions permitted per camera. Each region must be able to be individually tuned and have separate tuning parameters.

- h. This method of tuning must also provide a live tuning window whereby these settings and regions can be altered and tested prior to being used. This live tuning window shall show the live video as well as the regions of interest. During the time that motion is detected within a region, the border of the region shall change to a different colour. In this way, tuning can be performed to achieve the desired performance. Text shall also be provided in the window to alert the user that motion has been detected.
- 18. The NVMS shall allow camera output to be recorded for the following conditions:
 - a. Activated by a Security Management System alarm or event
 - b. Manually activated by a user viewing a live camera
 - c. Scheduled recording
 - d. Video Motion Detection
 - e. Event activated recording is a process that allows a segment of video or a snapshot to be associated with a Security Management System alarm or event.
 - f. User activated recording occurs when a user viewing live video chooses to record the currently viewed camera output by selecting the "Record" button.
 - g. Scheduled recording allows video to be recorded between start and stop times on defined days.
 - h. The Name, Description and Value of the Security Management System Server which activated the recording (for alarm/event activated recordings)
- 19. An embedded video player with controls (buttons) similar to a VCR (video cassette recorder). The information displayed on the video player and the controls provided shall include:
 - a. The time and date of the frame being displayed.
 - b. A slider control which is used to move backwards and forwards through the recording.
 - c. Play, pause and stop buttons.
 - d. Step forward and step backward buttons, to move through the recording frame by frame.
 - e. Fast forward and rewind buttons, to play the recording at speeds of x2, x4, x8, x16, etc (to a minimum of x1024).
 - f. A snapshot button, to allow for the frame being displayed to be stored as a bitmap file (in a similar way to the snapshot button for live video).
 - g. Information about the chosen recording. The following information as a minimum shall be displayed with the chosen recording.
 - h. The type of recording (operator activated, alarm/event activated, video motion detection or scheduled)
- 20. It is a requirement that all user actions on the Security/Digital Video Workstation be recorded in a log file along with the Security Management System's actions. User actions include:
 - a. Interventions such as manual recording and configuration setting changes
 - b. Cameras viewed.
 - c. Video replayed.
 - d. Video exported.
 - e. Cameras pan/tilt/zoomed and preset switching.
 - f. This log must also contain a history of the status of the NVMS system components.
 - g. It shall list the status of all cameras, streamers, servers and other system components including when they were disabled or failed.
 - h. The log of user and system actions shall be available in text format and automatically included with any video recordings that are exported.
 - i. The system shall support RAID 5 for video recordings (clips).
 - j. The Camera Server shall be able to manage several off-line media devices for archiving and restoring video. The Camera Server must use a standard archiving method such as Microsoft Remote Storage Services to handle offline media.

- k. The following off-line devices shall be supported:
 - 1) CD-RW/DVD-RW
- 21. The following system tasks shall be performed from the Security/Digital Video Workstation:
 - a. View live video.
 - b. Adjust the PTZ position of the camera.
 - c. Live video is automatically displayed on a monitor when an event occurs.
 - d. Search through the stored video clips of a camera
 - e. An operator records an incident.
 - f. An operator records a snapshot of the current viewed video.
 - g. Add a new camera to the system.
 - h. Change the configuration settings for a camera.
 - i. Provide alarm/event activated recording from the integrated Security Management System
 - j. Search for video clips from different cameras
 - k. Create a sequence (camera tour)
 - l. Conduct a sequence (camera tour)
 - m. Create a quad view.
 - n. View a quad view.

2.22 NETWORK VIDEO MANAGEMENT SYSTEM SERVERS

- A. The NVMS Servers shall be able to operate with no performance degradation using the following hardware and operating system configuration:
 - 1. Intel Quad Core 2 3.2 GHz or better
 - 2. 30 days of RAID 6 storage shall be provided for the continuous recording of all cameras at H.264, 1080p, 10fps.
 - 3. RAID 1 for Operating System
 - 4. CD/DVD burner
 - 5. Windows 2020 Server
 - 6. Dual 10/100/1000 Mbps NICs for network connection to the other components of the NVMS
 - 7. If equivalent hardware is proposed, then the supplier must be able to demonstrate compatibility of software as described in this specification.
 - 8. Proprietary hardware platforms are not acceptable.
 - 9. The Database Server shall contain a database of all network-connected cameras and their configuration.
- B. The NVMS server provided shall be complete with all required software, licensing and network configuration.
- C. The Database Server shall:
 - 1. Manage the system database, containing details including:
 - a. System configuration
 - b. Camera configuration and settings
 - c. Recording configuration and settings
 - d. Configuration of Quad Views and Sequences
 - e. Details of recordings
 - f. Schedules
 - g. Operator security details
 - h. Configuration of Surveillance and Alarm Monitors
 - i. Configuration of Video Motion Detection
 - j. Manage communication between the Security/Video Workstations and the Camera Servers
 - k. Allow alarms/events in the Security System to initiate recordings.

D. The Camera Server shall:

1. Manage live video from camera streamers.
2. Transmit live video to Security/Digital Video Workstations
3. Receive camera control commands from Security/Video Workstations and then send the commands to cameras.
4. Store live video to hard disk
5. Transmit previously stored video to Security/Video Workstations
6. Archive previously stored video to off-line storage media
7. Retrieve archived video from off-line storage media.
8. Provide video motion detection.

E. Security Workstation

1. Operator view shall be provided using a Security Workstation machine as described in this specification. Workstation shall be connected via a TCP/IP network to the Security Management System. Workstation shall be capable of viewing live video and recorded video from the Camera Servers and provide levels of operator security.
2. Proprietary hardware platforms are not acceptable.
3. The Security Workstation shall include application software with functionality described in this specification.
4. The Security Workstation shall at minimum use the following hardware and operating system configurations:
5. Intel Quad Core 2 3.2 GHz Processor
6. 8 GB DDR2 RAM
7. 500 GB HDD at 7200 RPM
8. 1080p LED Monitors (quantity and size as stated on the drawings)
9. 4GB Radeon Video Card
10. CD/DVD Burner
11. Windows 10
12. The NVMS workstation and the SMS workstation may be combined to one (1) workstation at locations indicated on the drawings.

F. Video Camera Power Supplies

1. Power over Ethernet (PoE)
 - a. All network (IP) video cameras shall be powered by Power over Ethernet (PoE).
 - b. PoE shall be distributed from the edge switch directly to the camera via CAT6 cabling.
2. All exterior cameras shall be powered via high power network switches and/or high power PoE injectors where required. The provision of all network switches and associated camera power budgeting shall be the responsibility for the contractor.
3. Should the power requirements of any camera exceed twelve (12) watts, an additional external high power PoE injector/midspan shall be installed in the equipment racks to which the associated cameras are cabled.
4. If any additional PoE injectors/midspans are needed, they shall be connected to the same UPS as the network switch, and the UPS shall be rated accordingly.

G. License Plate Recognition

1. The LPR shall be an IP-based device and/or software that provide advanced video processing, high plate reading performance and industrial grade durability.
2. The LPR shall be a fixed device or software module integrated into the NVMS platform.
3. The LPR shall be capable of reading multiple license plate styles common to North America.
4. The LPR shall be capable of reading both private and commercial license plates.
5. The LPR shall automatically read plates of stationary or moving vehicles up to a minimum speed 140MPH and a minimum viewing angle of 45 degrees.

6. Fixed LPR units shall be provided with rugged IP76 enclosures and be weatherproof and able to operate under outdoor temperature and weather conditions.

2.23 VIDEO SURVEILLANCE SYSTEM CAMERAS

- A. All video surveillance cameras shall be manufactured by Axis.
- B. The Contractor shall be responsible for verifying that the cable distances from each camera to the nearest network switch do not exceed ninety (90) metres. For those cameras that exceed the cable distance limitations the Contractor shall include for camera connections via PoE extenders and CAT6 cabling. The Contractor shall provide all required power supplies, connections, terminations and materials as required for a fully functional video surveillance system.
- C. All cameras are to be provided with a Video Management System software license.
- D. All cameras shall be ONVIF compliant.
- E. Indoor Fixed IP HD 1080P Dome Camera
 1. General Requirements
 - a. The camera shall be of manufacturer's official product line, designed for commercial/industrial 24/7/365 use.
 - b. The camera shall be based upon standard components and proven technology using open and published protocols.
 2. General
 - a. The camera shall:
 - 1) Be designed to provide video streams in HDTV 1080p (1920x1080) resolution at 30 frames per second using H.264 or Motion JPEG.
 - 2) Be equipped with Day/Night functionality and remote zoom and focus capabilities.
 - 3) Operate on an open-source platform, and include a built-in web server.
 - 4) Be equipped with a slot for SD/SDHC memory card expansion.
 - 5) Be manufactured with a tamper resistant body.
 3. Hardware
 - a. The camera shall:
 - 1) Use a high quality IR-sensitive progressive scan megapixel sensor.
 - 2) Be equipped with a removable IR-cut filter, providing so-called day/night functionality.
 - 3) Be equipped with a high quality varifocal lens with automated iris functionality, providing remote zoom and focus functionality.
 4. Video
 - a. Resolution
 - 1) The camera shall be able to deliver at least two individually configurable full frame rate video streams of resolutions up to HDTV over IP networks.
 - 2) Supported video resolutions shall include:
 - a) 1920x1080 (HDTV 1080p)
 - b. Encoding
 - 1) The camera shall:
 - a) Support Motion JPEG encoding in a selectable range from 1 up to 30 frames per second in all resolutions up to HDTV 1080p.
 - b) Support H.264 encoding in a selectable range from 1 up to 30 frames per second in all resolutions up to HDTV 1080p.

5. Transmission

- a. The camera shall allow for video to be transported over:
 - 1) HTTP (Unicast)
 - 2) HTTPS (Unicast)
 - 3) RTP (Unicast & Multicast)
 - 4) RTP over RTSP (Unicast)
 - 5) RTP over RTSP over HTTP (Unicast)
 - 6) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- b. Image control
 - 1) The camera shall incorporate Automatic and Manual White Balance and an electronic shutter operating in the range 1/6 and 1/35.500 second.
 - 2) The camera shall provide Wide Dynamic Range and backlight compensation with automatic and definable exposure zones.

6. Functionality

- a. Web server
 - 1) The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- b. IP addresses
 - 1) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - 2) The camera shall provide support for both IPv4 and IPv6.
- c. Event functionality
 - 1) The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a) External input
 - b) Video Motion Detection
 - c) Audio Detection
 - d) Schedule
 - e) Camera tampering
 - f) Local storage full
 - 2) Network interface
 - a) The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- d. Enclosure
 - 1) The camera enclosure shall include the following:
 - a) Manufactured with a tamper resistant body providing encapsulated electronics.
 - b) Clear and smoked transparent cover.
 - 2) The camera enclosure shall provide the ability to adjust the camera modules angle with at least $\pm 180^\circ$ horizontal, $\pm 85^\circ$ vertical and $\pm 170^\circ$ rotation while maintaining an image that is not interfered with by the camera housing.
- e. Power requirements
 - 1) Power over Ethernet according to IEEE 802.3af - Class 2.

f. Environmental

1) The camera shall:

- a) Operate in a temperature range of 0°C to +50°C (32°F to +122°F).
- b) Operate in a humidity range of 20–80% RH (non-condensing).

F. Outdoor Fixed IP HD 1080P Dome Camera

1. General Requirements

- a. The camera shall be of manufacturer's official product line, designed for commercial/industrial 24/7/365 use.
- b. The camera shall be based upon standard components and proven technology using open and published protocols.

2. General

a. The camera shall:

- 1) Be designed to provide video streams in HDTV 1080p (1920x1080) resolution at 30 frames per second using H.264 or Motion JPEG.
- 2) Be equipped with Day/Night functionality and remote zoom and focus capabilities.
- 3) Operate on an open-source platform, and include a built-in web server.
- 4) Be equipped with a slot for SD/SDHC memory card expansion.
- 5) Be manufactured with a tamper resistant body.

3. Hardware

a. The camera shall:

- 1) Use a high quality IR-sensitive progressive scan megapixel sensor.
- 2) Be equipped with a removable IR-cut filter, providing so-called day/night functionality.
- 3) Be equipped with a high quality varifocal lens with automated iris functionality, providing remote zoom and focus functionality.
- 4) Be manufactured with an all-metal body, support operation between -40 to +55°C (-40 to +131°F) and be both IP66 and NEMA 4X-rated.

4. Video

a. Resolution

- 1) The camera shall be able to deliver at least two individually configurable full frame rate video streams of resolutions up to HDTV over IP networks.
- 2) Supported video resolutions shall include:
 - a) 1920x1080 (HDTV 1080p)

b. Encoding

- 1) The camera shall:
 - a) Support Motion JPEG encoding in a selectable range from 1 up to 30 frames per second in all resolutions up to HDTV 1080p.
 - b) Support H.264 encoding in a selectable range from 1 up to 30 frames per second in all resolutions up to HDTV 1080p.

5. Transmission

a. The camera shall allow for video to be transported over:

- 1) HTTP (Unicast)
- 2) HTTPS (Unicast)
- 3) RTP (Unicast & Multicast)
- 4) RTP over RTSP (Unicast)
- 5) RTP over RTSP over HTTP (Unicast)

- 6) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- b. Image control
 - 1) The camera shall incorporate Automatic and Manual White Balance and an electronic shutter operating in the range 1/6 and 1/35.500 second.
 - 2) The camera shall provide Wide Dynamic Range and backlight compensation with automatic and definable exposure zones.
6. Functionality
 - a. Web server
 - 1) The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. IP addresses
 - 1) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - 2) The camera shall provide support for both IPv4 and IPv6.
 - c. Event functionality
 - 1) The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a) External input
 - b) Video Motion Detection
 - c) Audio Detection
 - d) Schedule
 - e) Camera tampering
 - f) Local storage full
 - 2) Network interface
 - a) The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - d. Enclosure
 - 1) The camera enclosure shall include the following:
 - a) Manufactured with an all-metal vandal resistant body providing encapsulated electronics.
 - b) Clear and smoked transparent cover.
 - c) IP66-rating
 - d) NEMA 4X-rating
 - e) Impact resistance of 2200lbs / 1000kg
 - f) Thermostat, heater and fan inside the enclosure
 - g) Fitted with a dehumidifying membrane.
 - h) Removable weather shield
 - 2) The camera enclosure shall provide the ability to adjust the camera modules angle with at least $\pm 180^\circ$ horizontal, $\pm 85^\circ$ vertical and $\pm 170^\circ$ rotation while maintaining an image that is not interfered with by the camera housing.
 - e. Power requirements
 - 1) Power over Ethernet according to IEEE 802.3af - Class 2.
 - f. Environmental
 - 1) The camera shall:
 - a) Operate in a temperature range of -40°C to $+55^\circ\text{C}$ (-40°F to $+131^\circ\text{F}$).
 - b) Operate in a humidity range of 15–100% RH (condensing).

G. Indoor IP PTZ Dome Camera

1. General Requirements
 - a. The camera shall be of manufacturer's official product line, designed for commercial/industrial 24/7/365 use.
 - b. The camera shall be based upon standard components and proven technology using open and published protocols.
2. General
 - a. The camera shall:
 - 1) Be designed to provide video streams in HDTV 1080p (1920x1080) resolution at 25/30 frames per second using H.264 or Motion JPEG.
 - 2) Be equipped with Day/Night functionality, provide high speed pan and tilt functions and be equipped with 20x optical and 12x digital zoom.
 - 3) Operate on an open-source platform, and including a built-in web server.
 - 4) Be equipped with a slot for SD/SDHC memory card expansion.
 - 5) Be manufactured with a tamper resistant body.
 - 6) Utilize Power over Ethernet supporting full functionality.
3. Hardware
 - a. The camera shall:
 - 1) Use a high quality IR-sensitive 1/2.8" progressive scan CMOS sensor.
 - 2) Be equipped with an automatically and manually removable IR-cut filter, providing so-called day/night functionality.
 - 3) Be equipped with a high quality F1.6 – F2.8 DC-iris lens with motorized 20x optical zoom providing a horizontal angle of view between 55.2° and 3.2°.
 - 4) Provide pictures down to 0.80 lux at F1.6 while in day mode (with IR-filter in use) and down to 0.04 lux at F1.6 while in night mode (with IR-filter removed).
 - 5) Be equipped with accurate high-speed pan-tilt functionality with 360° endless pan range and a 220° tilt range.
 - 6) Provide pan and tilt speed between 0.05° - 450°/sec.
4. Video
 - a. Resolution
 - 1) The camera shall be able to deliver at least two individually configurable full frame rate video streams of resolutions up to HDTV over IP networks.
 - 2) Supported video resolutions shall include:
 - a) 1920x1080 (HDTV 1080p)
 - b. Encoding
 - 1) The camera shall:
 - a) Support Motion JPEG encoding in a selectable range from 1 up to 30/25 frames per second in all resolutions.
 - b) Support H.264 encoding in a selectable range from 1 up to 30/25 frames per second in all resolutions.
 - c) Be able to provide independently configured simultaneous H.264 and Motion JPEG streams.
 - d) Support both Constant Bit Rate (CBR) and Variable Bit Rate (VBR) in H.264.
 - e) Provide configurable compression levels.
 - f) Support motion estimation in H.264.
5. Transmission
 - a. The camera shall allow for video to be transported over:
 - 1) HTTP (Unicast)
 - 2) HTTPS (Unicast)

- 3) RTP (Unicast & Multicast)
 - 4) RTP over RTSP (Unicast)
 - 5) RTP over RTSP over HTTP (Unicast)
 - 6) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
 - b. Image control
 - 1) Incorporate Automatic and Manual White Balance
 - 2) Be equipped with an electronic shutter and support automatic and manually defined exposure zones operating in the range 1/4 and 1/10.000 second.
 - 3) Provide Back Light Compensation.
 - 4) Allow for rotation of the image.
6. Functionality
 - a. Web server
 - 1) The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. IP addresses
 - 1) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - 2) The camera shall provide support for both IPv4 and IPv6.
 - 3) PTZ functionality
 - a) The camera shall:
 - Provide at least 100 preset positions.
 - Provide e-flip functionality, which will automatically rotate the image 180° electronically when following a moving object passing under the camera.
 - Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
 - Be able to detect and automatically follow moving objects in the cameras field of view.
 - c. Event functionality
 - 1) The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a) External input
 - b) Video Motion Detection
 - c) Audio Detection
 - d) Schedule
 - e) Camera tampering
 - f) Local storage full
 - 2) Network interface
 - a) The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - d. Enclosure
 - 1) The camera enclosure shall include the following:
 - a) Manufactured with a tamper resistant body providing encapsulated electronics

- b) Clear and smoked transparent cover
 - 2) The camera enclosure shall provide the ability to adjust the camera modules angle with at least $\pm 180^\circ$ horizontal, $\pm 85^\circ$ vertical and $\pm 170^\circ$ rotation while maintaining an image that is not interfered with by the camera housing.
 - e. Power requirements
 - 1) Power over Ethernet according to IEEE 802.3af - Class 2.
 - f. Environmental
 - 1) The camera shall:
 - a) Operate in a temperature range of 0°C to $+50^\circ\text{C}$ (32°F to $+122^\circ\text{F}$).
 - b) Operate in a humidity range of 20–80% RH (non-condensing).
- H. Indoor/Outdoor Multi-head IP HD 1080P $180^\circ/360^\circ$ Dome Camera
 - 1. The panoramic network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open-source; Linux-based platform, and including a built-in web server.
 - b. The camera shall be equipped with minimum three (3) (for 180° cameras) and four (for 360° cameras) degree progressive scan megapixel sensors.
 - c. The camera shall provide flexible positioning of multi-head varifocal camera heads.
 - d. The camera shall provide the following field of view:
 - 1) $3/4\times 1080\text{p}$
 - 2) Horizontal: $108^\circ - 54^\circ$
 - 3) Vertical: $57^\circ - 30^\circ$
 - 4) $3/4\times 720\text{p}$
 - 5) Horizontal: $67^\circ - 36^\circ$
 - 6) Vertical: $37^\circ - 20^\circ$
 - 7) The camera shall provide adjustable focus and zoom functionality.
 - 8) The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - 9) The camera shall be manufactured with an IP66-, NEMA 4X- and IK09-rated Die-casted aluminum casing.
 - 2. Hardware
 - a. The camera shall:
 - 1) Use a high quality IR-sensitive progressive scan megapixel sensor.
 - 2) Be equipped with a removable IR-cut filter, providing so-called day/night functionality.
 - 3) Be equipped with a high quality varifocal lens with automated iris functionality, providing remote zoom and focus functionality.
 - 4) Be manufactured with an all-metal body, support operation between -40 to $+55^\circ\text{C}$ (-40 to $+131^\circ\text{F}$) and be both IP66 and NEMA 4X-rated.
 - 3. Video
 - a. Resolution
 - 1) The camera shall be able to deliver at least two individually configurable full frame rate video streams of resolutions up to HDTV over IP networks.
 - 2) Supported video resolutions shall include:
 - a) 1920×1080 (HDTV 1080p)
 - b. Encoding
 - 1) The camera shall:
 - a) Support Motion JPEG encoding in a selectable range from 1 up to 30 frames per second in all resolutions up to HDTV 1080p.

- b) Support H.264 encoding in a selectable range from 1 up to 30 frames per second in all resolutions up to HDTV 1080p.
- 4. Transmission
 - a. The camera shall allow for video to be transported over:
 - 1) HTTP (Unicast)
 - 2) HTTPS (Unicast)
 - 3) RTP (Unicast & Multicast)
 - 4) RTP over RTSP (Unicast)
 - 5) RTP over RTSP over HTTP (Unicast)
 - 6) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
 - b. Image control
 - 1) The camera shall incorporate Automatic and Manual White Balance and an electronic shutter operating in the range 1/6 and 1/35.500 second.
 - 2) The camera shall provide Wide Dynamic Range and backlight compensation with automatic and definable exposure zones.
- 5. Functionality
 - a. Web server
 - 1) The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. IP addresses
 - 1) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - 2) The camera shall provide support for both IPv4 and IPv6.
 - c. Event functionality
 - 1) The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a) External input
 - b) Video Motion Detection
 - c) Audio Detection
 - d) Schedule
 - e) Camera tampering
 - f) Local storage full
 - 2) Network interface
 - a) The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - d. Enclosure
 - 1) The camera enclosure shall include the following:
 - a) Be manufactured with an IP66-, NEMA 4X- and IK09-rated Die-casted aluminum casing.
 - b) Be fitted with a polycarbonate dome.
 - 2) The camera enclosure shall provide the ability to adjust the camera modules angle with at least $\pm 180^\circ$ horizontal, $\pm 85^\circ$ vertical and $\pm 170^\circ$ rotation while maintaining an image that is not interfered with by the camera housing.
 - e. Power requirements
 - 1) Power over Ethernet according to IEEE 802.3af - Class 2.

f. Environmental

1) The camera shall:

- a) Operate in a temperature range of -30°C to +60°C (-22°F to 140°F).
- b) Operate in a humidity range of 10–100% RH (condensing).

2.24 NVMS VIDEO ENCODERS

A. General

1. The video encoder shall:

- a. Be equipped with four (4), eight (8) or twelve (12) analogue video input(s).

B. Description

1. The device shall:

- a. Be based upon standard components and proven technology using open and published protocols.
- b. Be of the latest model available by the manufacturer and support the latest firmware released for that model.
- c. Be designed to provide video streams using H.264 or Motion JPEG image compression methods.
- d. Be equipped with bi-directional audio connections.
- e. Comply with the environmental and logical requirements and be of the technology family:

2. H.264 Analogue Video Encoder

- a. Utilize Power over Ethernet (PoE) allowing the device and fan functions to be powered over the network cable or external power source to allow operation at lower temperature ranges.
- b. Contain a built-in web server making video and configuration available to in a standard browser environment using HTTP, without the need for additional software.
- c. Web server shall support multiple users with different permission levels and unique usernames and password.

3. Performance

a. Video

- 1) The device shall be capable of simultaneously delivering up to four independent streams each from an independent video/audio source, for use when connected to the Video Management Software for recording and live viewing.
- 2) The device(s) shall support the video resolution prescribed in the scope of work and be capable of generating the following image rates (in frames per second – fps) regardless of the complexity of the scene:
 - a) 720x480 (NTSC) @ 30fps
 - b) 720x576 (PAL) @ 25fps
 - c) 352x240 (NTSC) @ 30fps
 - d) 352x288 (PAL) @ 25fps

4. Encoding

a. The device shall:

- 1) Be able to provide
- 2) Up to four independently configured simultaneous video streams
- 3) Either H.264 or Motion JPEG per stream
- 4) One stream per independent video source

b. Support Motion JPEG encoding:

- 1) Selectable range from 1 up to 30 NTSC/25 PAL frames per second.
 - 2) Supports compression and image quality settings from 1 to 64
 - 3) Provide user configuration of compression quality, bandwidth and image rate per device.
 - c. Support H.264 encoding:
 - 1) Selectable range from 1 up to 30 NTSC/25 PAL frames per second.
 - 2) Supports Variable Bit Rate (VBR) in H.264 with a configurable maximum bit rate threshold.
 - 3) Provide user configuration of compression format, compression quality, maximum bit rate, key frame interval, and image rate per device.
 - 4) Support G.711 PCM 8kHz audio compression.
 - 5) Up to four audio connections per device
 - 6) Each connection shall be able to support bi-directional encoding/decoding.
 - 7) Audio encoding/decoding processes shall not be affected by the number of audio streams or the amount of video being processed.
5. Transmission
 - a. The device shall allow for video and audio to be transported over:
 - 1) HTTP (Unicast)
 - 2) HTTPS (Unicast)
 - 3) RTP (Unicast & Multicast)
 - 4) RTP over RTSP (Unicast)
 - 5) RTP over RTSP over HTTP (Unicast)
 - 6) RTP over RTSP over HTTPS (Unicast)
6. Image Control
 - a. The device shall support user configuration of:
 - b. Image compression and quality
 - c. Image rate of encoding (frames per second)
 - d. Motion detection sensitivity and threshold
7. Network
 - a. The device shall support both fixed (static) IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The device shall support user configuration of network parameters including:
 - 1) Fixed (static) IP address.
 - 2) Subnet mask
 - 3) Gateway
 - 4) Control Port
 - c. The device shall allow for automatic detection of the device when using a Video Management Application (VMA) or Network Video Recorder (NVR) supporting this feature.
 - d. The device shall provide support for both IPv4 and IPV6 Networks.
8. Security
 - a. The device shall:
 - 1) Support the use of password protection, and HTTPS encryption.
 - 2) Restrict access to the built-in web server by usernames and passwords at three different user group levels.
 - 3) Support SSL for data communication.
 - 4) Provide configurable 802.1x port based authentication.
9. API support
 - a. The device shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.

- b. The device shall conform to the network video standard version 1.02, version 2.00 and Profile S as defined by the ONVIF organization (www.onvif.org).
- 10. Materials
 - a. The device shall be factory assembled and designed for continuous 24/7/365 use in commercial/industrial applications.
 - b. The device shall provide the following mechanical requirements:
 - 1) Be equipped with four (4) alarm input and four (4) output terminals.
 - 2) Be equipped with four (4) line audio input (for external microphone) and four (4) audio output (for external speaker) connections.
 - 3) Be equipped with a firmware reset button to reset the device to factory default settings.
 - 4) Be equipped with a serial communication RS-485 terminal strip.
 - 5) The device shall provide the following device diagnostics:
 - 6) Be equipped with LEDs, indicating the device's functional status.
 - 7) Allow users to disable status LEDs.
 - 8) Be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - 9) The device shall provide physical interfaces to external devices & systems:
- 11. Network interface
 - a. The device shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto negotiation of network speed (100 Mbps and 10 Mbps) and transfer mode (full and half duplex).
- C. Audio / Input Terminals
 - 1. The device shall be equipped with four (4) input terminals for sending and/or receiving line level analogue audio from an external microphone and to an external speaker.
 - 2. Audio input/output terminals shall be 3.5mm mini jack.
- D. Analogue Video input
 - 1. The device shall be equipped with four (4) NTSC/PAL, BNC (Bayonet Neill–Concelman) connector supporting 1.0 Volt peak to peak with 75 Ohm selectable termination.
- E. External I/O Terminals
 - 1. The device shall be equipped with four (4) alarm input terminals and four (4) alarm output terminals.
 - 2. Alarm inputs shall be individually configured for normally open/normally closed.
 - 3. Alarm outputs shall be individually configured.
 - 4. Normally open/normally closed.
 - 5. Duration of state change when triggered.
 - 6. The device enclosure shall include the following:
 - a. Anodized aluminum housing with proper ventilation.
 - b. Provide the ability to be rack mounted.
 - c. The device enclosure shall not exceed these dimensions:
 - d. 140 mm x 123 mm x 38 mm / 5.5" x 4.8" x 1.5"
 - e. The device enclosure shall not exceed these weights:
 - f. 0.62 kg (1.4 lbs)
 - g. The device shall be capable of being powered by the following power sources:
 - 1) PoE: up to IEEE 802.3af Class 3 PoE Compliant
 - 2) 12 V DC +/-10%
 - 3) 24 V AC +/-10%
 - h. The device power consumption shall:
 - i. Not to exceed 8 W

7. The device shall be connected to power through:
 - a. Ethernet connection with IEEE 802.3af Class 3 PoE power
 - b. 2-pin connector with external power
 - c. The device shall operate in the following environment:
 - 1) Operate in a temperature range of:
 - 2) 12V DC: -10° C to +48° C (14° F to +118° F)
 - 3) 24V AC or PoE: -10°C to 50°C (14°F to 122°F)
 - 4) Operate in a humidity range of 20–80% relative humidity (non-condensing)
- F. Be stored in a temperature range of -10° C to +70° C (14°

2.25 DURESS ALARM / PANIC SYSTEM

- A. The duress alarm / panic system shall be an extension of the existing Edwards Code White system currently existing on site. The security contractor shall provide all new Edwards fire alarm panels for the 3rd floor that shall be used solely for the annunciation of the panic alarm Code White buttons. The new Edwards panel shall connect to the existing Edwards based Code White system for the annunciation of all alarms at the existing Forensics Security Office.

2.26 SECURITY SYSTEMS INTEGRATION

- A. The Security Contractor shall provide all required materials, low voltage wiring, licenses, software, configuration, programming and testing required for the following subsystem integrations.
- B. Access Control and Alarm Monitoring with Automated Door Operators
 1. The following is a description of the intended functionality and integration between automated door operators and security devices.
 2. The non-secure or public side shall be equipped with a card reader and automated door operator pushbutton.
 3. The secure side shall be equipped with a request to exit device and automated door operator pushbutton.
 4. To gain entry to the secured side from the public, the following sequences of operation shall occur:
 - a. An invalid access control card is presented to the card reader. The door remains secure and the automated door operator pushbutton, which is equipped with a normally open contact connected to the door opener assembly, remains open.
 - b. A valid access control card is presented to the card reader. The lock is temporarily released, the door contact is shunted and the normally open contact connecting the automated door operator pushbutton to the door opener assembly is closed.
 5. The user may either physically open the door using the handles or may use the pushbutton for automatic opening (for a pre-determined amount of time).
 6. The contact connecting the door operator pushbutton to the motor assembly shall only be closed upon the presentation of a valid access control card to the card reader. Once the contact has been closed, it shall open when the locking device re-secures.
 7. To leave the secured area and enter into public/non-secured space, the following sequences of operation shall occur:
 - a. The user approaches the point of free egress and presses the pushbutton request to exit.
 - b. The locking device is temporarily defeated, the door contact is shunted and the normally open contact connecting the automated door operator pushbutton to the door opener assembly is closed.
 - c. The user may either physically open the door using the handles or may use the door operator pushbutton for automatic opening (for a pre-determined amount of time).

C. Access Control and Alarm Monitoring with Video Surveillance

1. This section describes the access control network level interface to the video surveillance system. The software requirements detailed herein shall be met in their entirety.
2. The access control servers shall establish communications with the video surveillance system switch servers.
3. Both the access control primary and redundant servers shall be interfaced to both the video switch primary and redundant servers, such that any single failure of the access control or surveillance systems shall not disrupt the ability of the integration.
4. The communications shall use the Ethernet TCP/IP protocol.
5. Each and every access control data gathering panel alarm point and status point shall be interfaced such that at a minimum the following data message may be transmitted to the video surveillance system:
 6. Command camera 'x' to position 'y'.
 7. Display camera 'x' on monitor 'y'.
 8. Record camera 'x' at 'y' speed.
 9. Assign unique video segment identifier, set segment start flag.
 10. End video segment and set IP camera to normal view parameters.
 11. All messages shall be transmitted and received in an event-based manner.
12. The access control to video surveillance system interface shall incorporate a communication validation function that regularly tests the interface for proper operation. This validation may be in the form of a scheduled test command to the surveillance system.
13. The video surveillance system shall return an 'acknowledge' or similar message to indicate the access control command was received and executed.
14. The access control to video surveillance interface shall report communication failure in any command sent from the access control server system does not receive a corresponding acknowledgment.

PART 3 - EXECUTION

3.1 INSTALLATION AND MATERIAL STANDARDS

- A. Quality of Installation.
- B. The Security Contractor is to provide a qualified, thorough and professional installation crew.
- C. During installation, the Security Contractor must observe, understand and obey all site safety rules and regulations. Moreover, all pertinent codes as well as proper practice in procedure must be adhered to.
- D. The security system shall be installed as required in proper conduits. The Security Contractor shall provide all miscellaneous parts, equipment, and labour necessary to ensure complete and correct operation of the system.
- E. All installed wire, cable and conduit must be of the correct type, quantity and size as specified or required by the manufacturer.
- F. The Security Contractor is to gain consent from either Owner or Owner appointed project manager in order to begin installation.

END OF SECTION