

Project/File: Fort St. James Arena Upgrade
Addendum No.: 3
Date: November 21, 2024
To: All Proponents
RFP No.: RFP2024-005

This addendum is to be read with and constitutes part of the Request for Proposals document.

INSTRUCTIONS:

1. Amend your copy of the Request for Proposals as directed below.
2. Retain one copy of this Addendum for your file; sign and return a second copy and attach to your submission as confirmation the Addendum was accounted for in your Proposal submission.
3. Failure to sign and return this form may result in a non-compliant Proposal.

DETAILS OF THE ADDENDUM:

Make the following changes to Request for Proposals RFP2024-005:

1. CLARIFICATIONS, QUESTIONS AND ANSWERS:

- 1.1. The following clarifications are issued in response to discussions at proponents' site meeting:
 - 1.1.1. **RFP Section 4.7.1 – Consent of Surety:** Provide Contract security in form of Performance Bond and Labor and Material Payment Bond, each in an amount equal to 50% of the Contract Price.
 - 1.1.2. **Section 01 11 00 – Summary of Work, Article 1.4 Contractor's Use of Premises:** The District of Fort St James has confirmed Contractor will have unrestricted use of Project area (not including ice rink and change rooms) from April 1 to November 1, 2025.
 - 1.1.3. **Section 02 81 16 Hazardous Materials – Scope of Work:** Building has not been tested for asbestos-containing materials, but testing will be undertaken in the near future so scope of work for this item can be clarified prior to construction. For proposal pricing purposes, Section 02 81 18 is not included. If required, this scope of work will be added by Change Order to the contract at a future date.
 - 1.1.4. **Section 02 41 19 Selective Demolition:** The District of Fort St. James reserves the right to retain ownership of specific removed materials at its discretion, including but not



necessarily limited to doors; however, this does not apply to existing millwork / trophy cases, which shall be removed and disposed of by the Contractor.

1.1.5. **Section 01 56 00 Temporary Barriers and Enclosures:** The District of Fort St James will remove existing building's contents from Project work areas prior to commencement of the Work and store in District-provided storage.

1.1.6. **Division 32 – Site Improvements:** Where asphalt paving requires removal to allow new sidewalk installation at front of building, saw-cut for removal / installation of sidewalks as neatly as is reasonably possible. Contractor is not responsible for asphalt patching between old work and new and will be completed by the District as a part of its Public Works annual paving program.

2. APPENDIX C - Project Specifications:

2.1. Added Section 01 25 00 Substitution Procedures

2.2. Mechanical Specifications:

2.2.1. Re-issued sections:

21 13 00 Fire Suppression Sprinkler Systems

21 25 00 Fire Extinguishers

21 99 65 Acceptable Fire Suppression Equipment Manufacturers

22 05 00 Common Work for Plumbing Systems

22 07 13 Plumbing Piping Insulation

22 99 65 Acceptable Plumbing Equipment Manufacturers

23 73 11 Air Handling Units – Custom

23 81 10 Packaged Indoor Heating-Cooling Units

23 83 00 Radiant Heating-Cooling Units

23 99 65 Acceptable HVAC Equipment Manufacturers

25 05 00 Common Work Results for Control Systems

25 09 13 Instrumentation and Control Devices

25 90 10 Control Sequences and Operations

3. APPENDIX D - Project Drawings:

3.1. Mechanical

3.1.1. Electric heater schedule revised. EAC-1 to EAC-4 selection updated to be different model. Refer to M-400 for more information.

3.1.2. Air handling unit schedule revised. AHU-1 selection updated to include additional notes. Refer to M-400 for more information.

3.2. Electrical

3.2.1. The breaker and conduit sizes for air curtains EAC-1 to EAC-4 have been revised. Refer to E301 for more information.

Attachments: M-400, E301, Mechanical Specifications, Section 01 25 00 Substitution Procedures

END OF ADDENDUM 3

Firm Name: _____

Authorized Signature: _____

Printed Name: _____

Date: November 21, 2024

Part 1 General

1.1 DEFINITIONS

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

1.2 SUBSTITUTION PROCEDURES

- .1 Contractor may propose a Substitution wherever a material, Product, or manufacturer is specified by proprietary name(s), unless there is accompanying language indicating that Substitutions will not be considered.
- .2 Contractor may propose a Substitution wherever a material, Product, or manufacturer is specified by proprietary name(s) and accompanied by language such as, "or approved substitution" or other similar words. Do not construe such language as an invitation to unilaterally provide a Substitution without Consultant's prior acceptance in writing.
 - .1 Do not order or install a Substitution without a Change Order.
- .3 Provided proposed Substitution request includes all information specified in this Section under Submission Requirements For Proposed Substitutions, Consultant will promptly review and accept or reject proposed Substitution in consultation with Owner.
- .4 Consultant may accept a Substitution if satisfied that:
 - .1 the proposed substitute Product is the same type as, is capable of performing the same functions as, interfaces with adjacent work the same as, and meets or exceeds the standard of quality, performance and, if applicable, appearance and maintenance considerations, of the specified Product,
 - .2 the proposed substitute manufacturer has capabilities comparable to the specified manufacturer, and
 - .3 the Substitution provides a benefit to Owner.
- .5 Failure by Contractor to order a specified Product or a Product by a specified manufacturer in adequate time to meet Contractor's construction schedule is not a valid reason to accept a Substitution.
- .6 If Consultant accepts a Substitution, subject to Owner's agreement, the change in the Work will be documented in the form of a Change Order in accordance with Section 01 26 00 – Contract Modification Procedures.
- .7 If a Substitution is accepted, Contractor shall not revert to an originally specified material, Product, or manufacturer without Consultant's written acceptance.

1.3 SUBMISSION REQUIREMENTS FOR PROPOSED SUBSTITUTIONS

- .1 Submit each Substitution request on attached Substitution Form, along with:
 - .1 Identification of the Substitution, including product name and manufacturer's name, address, telephone numbers, and website.
 - .2 Reason(s) for proposing the Substitution.

- .3 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 and warranties of other parts of the Work.
 - .5 Manufacturer's Product literature for the Substitution, including material descriptions and product data sheets, installation instructions, 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 physical properties and performance characteristics of specified Product and the Substitution, highlighting significant variations.
 - .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 required Work to accommodate the Substitution and consequential effects on performance of the Work as a whole.
- .2 A later claim for an increase in Contract Price or Contract Time for other changes in the Work attributable to a Substitution will not be considered.

Part 2 Products – Not Used.

Part 3 Execution – Not Used.

END OF SECTION
(Substitution Request Form to follow)

SUBSTITUTION REQUEST FORM

Contractor must complete this form when requesting a substitution of manufacturer, material, Product, or system.

1. Before making Substitution request, Contractor shall review all submittals, adjacent site conditions, schedule and cost impacts, and other factors that may impact the Work.
2. Consultant will not review request for Substitution unless this form is properly completed and required information attached.
3. Consultant will reject request for Substitution if Contractor has filled out the form with wording such as "to be determined" or "to be provided at a later date."

Spec Section Title: _____ **Section No.** _____

Specified Product: _____

Reason for Substitution _____

Proposed Substitution: _____

Benefit to Project: _____

Impact on Adjacent Work: _____

Cost Impact to Project:
(clearly indicate amount of increase or reduction) _____

Schedule Impact to Project:
(clearly indicate impact in days) _____

Signature of Contractor's Authorized Representative _____ *Date Signed*

Name and Title of Contractor's Representative

Provide applicable WHMIS Safety Data Sheets with each request for substitution.

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides General, Product, and Execution Requirements for Fire Suppression Sprinkler Systems.
- .2 Provide all required Fire Suppression Sprinkler Systems as indicated, including, but not limited to:
 - .1 Wet sprinkler systems throughout the renovated area.
 - .2 Dry sprinkler systems at designated areas subject to freezing.
- .3 The Fire Suppression Contractor shall retain the services of a Contractor's Supporting Professional Fire Protection Engineer (Delegated Design).
- .4 The Fire Suppression Contractor shall retain the services of a Contractor's Supporting Professional Seismic Engineer (Delegated Design).
- .5 Obtain flow and pressure test data from municipal utility service for use in system design.
- .6 Supply and install seismic restraints for all fire suppression sprinkler piping systems in accordance with National Fire Protection Association NFPA-13, the provincial Building Code, and local Building By-Laws.
- .7 Provide all fire suppression sprinkler system piping as depicted on the drawings to and including all fire department connections, risers, sprinklers, sprinkler zone valves, and all other inlets and outlets that require piping connections for water based wet or dry fire suppression sprinkler systems.
- .8 The responsibility for allowing for all sprinklers for a complete installation is to be included in this Section of the work within the base tender price.
 - .1 The layout on the drawings shows the general intention of the work and sprinkler locations with respect to other ceiling elements such as ceiling tiles, lights, and diffusers.
 - .2 The Contractor shall provide all additional sprinklers as may be required.
 - .3 No request for extra cost will be considered based on failure of the Contractor to allow for extra sprinklers as required during construction to conform to all National Fire Protection Association requirements and the Authority Having Jurisdiction, whether shown on the drawings or not.
 - .4 Include sprinklers in concealed spaces containing exposed combustible construction including exposed wood beams, exposed wood framing and exposed wood ceiling materials.
- .9 Connect the fire suppression sprinkler system piping to receive water supply from the water service main as indicated on the drawings.

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 21 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 21.
- .4 Refer to and comply with the following sections:

- .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Fire Suppression Systems - Division 21
 - .4 Plumbing Systems - Division 22
 - .5 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .6 Controls and Instrumentation - Division 25
 - .7 Electrical - Division 26/27/28
- .5 Coordinate with Division 26/27/28 Electrical for connection of all supervised isolation valves to supervisory signals, flow switches to alarm signals, and supervisory switches to supervisory signals on the fire alarm system.
 - .6 Coordinate the work of this Section with the HVAC trades, plumbing trades, electrical trades, and ceiling trades.

1.3 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 All installation, execution, and testing shall conform to the following standards as a minimum:
 - .1 Provincial Building Code
 - .2 Local building by-Laws
 - .3 Fire protection equipment and installation shall be approved by local Fire Commissioner.
 - .4 National Fire Protection Association NFPA-13 Standard for the Installation of Sprinkler Systems.

1.4 QUALITY ASSURANCE

- .1 Refer to Section 21 05 00 Common Works, Quality Assurance, for additional details.
- .2 Refer to Section 21 05 00 Common Works, Quality Assurance, for requirements related to retaining the services of a Contractor's Supporting Professional Fire Protection Engineer (Delegated Design)
- .3 Any drawings prepared by the Consultant are provided only to show the general features of the systems, and general concepts of the arrangement and locations of the sprinklers and distribution system.
- .4 The Fire Suppression Contractor shall retain the services of a Contractor's Supporting Professional Seismic Engineer (Delegated Design)
- .5 Fire protection equipment and installation shall be approved by local Fire Commissioner.

1.5 SUBMITTALS

- .1 Comply with Section 21 05 00 Common Work for Fire Suppression Systems.
- .2 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 21 Fire Suppression.
- .3 Product Options and Substitutions
 - .1 Refer to Section 20 05 00, for requirements pertaining to product options and substitutions.
- .4 Shop Drawings
 - .1 Refer to Section 20 05 00, for requirements pertaining to product options and substitutions.

- .2 Submit shop drawings in accordance with Division 1 and Section 20 05 05 Documentation and Submittals.
 - .3 Refer to Section 21 05 00 Common Works, Quality Assurance, for detailed requirements related to retaining the services of a Contractor's Supporting Professional Fire Protection Engineer (Delegated Design).
 - .4 The Fire Suppression Contractor and their Supporting Professional Fire Protection Engineer (Delegated Design) shall include for all sprinklers as required to fully comply with NFPA-13, local by-laws and the provincial Building Code and Local Building By-Laws, whether or not they are indicated on the Consultant's, Architect's, or any other drawings.
 - .5 Indicate on the drawings all information required by the Authority Having Jurisdiction including features of the building construction, direction and size of beams, ceiling configurations, partition locations, as well as light fixtures (noting the depths of surface mounted light fixtures where these occur) and diffuser locations.
 - .6 Stipulate the positions and elevations of the sprinklers with respect to the floor elevations; the temperature rating all sprinklers; the spacing and types of hangers; drains and low point drains; test and flushing connections; types of sprinkler alarms; locations and types of sprinkler control valves; backflow preventers and all other essential features of the piping systems.
 - .7 Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Shop drawings are required for all materials and equipment.
- .5 Maintenance Data
 - .1 Refer to Division 1 and Section 20 05 05 Documentation and Submittals.
 - .2 Submit manufacturer's recommended maintenance tasks for a one-year period. Include maintenance schedules and lubrication products.
 - .6 Record Drawings
 - .1 Refer to Division 1 and Section 20 05 05 Documentation and Submittals.
 - .7 Occupancy Documentation Requirements
 - .1 Refer to Division 1 and Section 20 05 05 Documentation and Submittals.

Part 2 Products

2.1 GENERAL

- .1 All pipe, fittings, couplings, valves, devices, and materials used in the fire suppression standpipe system shall be of an approved type.
 - .1 All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - .2 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
- .2 System components shall be rated for working pressures not less than the maximum pressure to be developed at their corresponding locations within the system under any condition, including the pressure that occurs when a permanently installed fire pump is operating at shutoff pressure.

2.2 SPRINKLER PIPING AND FITTINGS - ABOVE GROUND

- .1 Where system working pressures exceed 1035 kPa [150 psig] provide valves with a minimum listed working pressure of 2060 kPa [300 psig] or as required.
- .2 Combined potable water and fire suppression sprinkler system portion of the piping upstream of the approved double check valve assembly backflow prevention device shall comply with Section 22 11 00 Domestic Water Distribution.
- .3 Sprinkler system piping:
 - .1 Steel pipe, black or hot dipped galvanized, standard weight or lightwall, material and IPS dimensions conforming to NFPA 13 and ASTM A53, ASTM A135 or ASTM A795.
 - .2 Ductile iron pipe or copper pipe for the portion of the combined potable water and fire suppression system upstream of a ULC listed backflow prevention device, as per Section 21 12 00.
 - .3 CPVC plastic piping is not acceptable for this project.
- .4 Sprinkler system fittings:
 - .1 Compatible with the piping material and suitable for the maximum pressures in the system but not less than 1210 kPa [175 psig] working pressure.
 - .2 Welded fittings shall conform to ANSI B16.5, B16.9, B16.11 and B16.25 and ASTM A234.
 - .3 Threaded fittings conforming to ANSI B16.1, B16.3 and B16.4 are acceptable on minimum Schedule 40 steel pipe up to 150 mm [6"] diameter and minimum Schedule 30 steel pipe for 200 mm [8"] diameter and larger and shall have a ULC corrosion resistance ratio of 1.00 or greater.
 - .4 Grooved end fittings shall be ductile iron conforming to ASTM A536, and shall provide full flow design, short pattern, with flow equal to standard pattern fittings.
 - .1 Fittings, couplings, and gaskets shall be of one manufacturer and shall provide a rigid joint. Grooving tools shall be of the same manufacturer as the grooved components.
 - .2 Standard of Acceptance: Victaulic FireLock™.
 - .5 Branch connections may be provided by bolted mechanical branch connections complete with synthetic rubber gaskets approved for line service.
 - .1 Standard of Acceptance: Victaulic Style 920920N and 922.
 - .6 Victaulic 922 outlet tees shall have cast upper and lower housings and may be used for up to 25 mm [1"] branch outlets and individual sprinklers.
 - .7 Victaulic "Pressfit System" of pipe and cold drawn carbon steel fittings with integral synthetic O-ring is not acceptable for this project.
 - .8 Victaulic "Vicflex™ Dry Sprinkler heads are acceptable for locations that require dry sprinkler protection (soffits etc.).
 - .9 Grooved joint couplings shall consist of two ductile iron housing segments conforming to ASTM A536, pressure responsive gasket to ASTM D2000, and zinc electroplated steel bolts and nuts.
 - .1 Rigid Type:
 - .1 Housings shall be cast with offsetting angle pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13. Couplings shall be fully installed at visual pad-to-pad offset contact.
 - .2 Tongue and recess type couplings, or any coupling that requires exact gapping of bolt pads on each side of the coupling at specified torque ratings, are not allowed.

- .3 32 mm [1-1/4"] through 100 mm [4"]: Installation Ready, for direct stab installation without field disassembly.
- .4 Standard of Acceptance: Victaulic Style 107, Victaulic FireLock™ Style 005H or Victaulic Zero-Flex Style 07
- .2 Flexible Type:
 - .1 For use only in locations where vibration attenuation and stress relief are required, and for seismic applications.
 - .2 Standard of Acceptance: Victaulic Installation Ready Style 177 and Style 75 / 77.
 - .3 For dry pipe systems, use a FlushSeal® coupling gasket in rigid and flexible couplings where required by NFPA 13.
 - .1 Standard of Acceptance: Victaulic Style 005 Firelock and Style 75
- .10 Submit requests for consideration of other products or systems in accordance with the submittal procedures, prior to the closing of this subtrade tender.
- .5 The Victaulic Vic-Flex multiple use flexible stainless steel drop system may be used to properly locate sprinkler heads.
 - .1 The drop system shall be supplied with required supporting members and bracing.

2.3 SYSTEM VALVES

- .1 Where system working pressures exceed 1035 kPa [150 psig] provide valves with a minimum listed working pressure of 2060 kPa [300 psig].
- .2 Gate - 1210 kPa [175 psig] - ULC listed:
 - .1 12 mm - 50 mm [1/2" - 2"]: Standard of Acceptance: Jenkins 305-U, Crane 459, Nibco T-104-0, Kennedy.
 - .2 64 mm [2½"] and larger: Standard of Acceptance: Jenkins 825, Crane 467, Nibco F-607-0TS, Kennedy; Grooved end valves shall be Victaulic Series 771.
- .3 Butterfly - 2065 kPa [300 psig] - ULC listed, or UL and FM approved, with handwheel and weatherproof actuator housing:
 - .1 12 mm - 50 mm [1/2" - 2"]: Butterball slow close butterfly valve with indicator and integral supervisory switch,
 - .1 Standard of Acceptance: Nibco KT-505-8, Victaulic 728 Firelock ball valve.
 - .2 50 mm - 300 mm [2" - 12"]: Standard of Acceptance: Demco Series NE-H with tapped lug end design, -Nibco L-002-N6 complete with gear operator and indicator, and pressure responsive seat. The valve stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.
 - .1 Standard of Acceptance: Victaulic 705 Firelock butterfly valve.
- .4 Check - 1210 kPa [175 psig] - ULC listed:
 - .1 64 mm [2½"] and larger:
 - .1 Standard of Acceptance: Jenkins 477, Crane 375, Nibco F-908-W, Kennedy, Victaulic Style 717.
 - .2 Provide a spool piece to ensure full check valve opening where adjacent to an alarm valve or gate valve.
- .5 Pressure Reducing - ULC listed:
 - .1 64 mm [2½"] in-line valve: modulating piston type pressure reducing valve.
 - .1 Standard of Acceptance: Zurn Z-3005IL, Watts 500.

- .2 100 mm - 200 mm [4" - 8"] in-line valve: Pilot operated type pressure reducing valve,
 - .1 Standard of Acceptance: Clayton 90-21.
- .3 If pressure reducing valve is left in the "normally open" position it shall be provided with either an integral or separate supervisory switch.
- .4 Outlet pressures on all pressure reducing valves shall be set at 690 kPa [100 psig] unless otherwise indicated, at a discharge rate of 6.3 L/s [100 USgpm] for 38 mm [1½"] size and 15.8 L/s [250 USgpm] for 64 mm [2½"] size.
- .5 All pressure reducing valves providing reduced pressure water to two or more outlet connections shall be the modulating piston type pressure reducing valve.
- .6 Pressure regulating sprinkler zone control valve - 2750 kPa [400 psig] - ULC listed:
 - .1 64 mm [2 ½"]: cast brass, straight pattern valve, rough brass finish with red wheel handle, female threaded outlet, 2760 kPa [400 psig] rated. Capable of field adjustment of the pressure.
 - .2 Standard of Acceptance: NFE model A203NB
- .7 Test and Drain Valves - 1210 kPa [175 psig] - ULC listed
 - .1 25 mm and 50 mm [1" through 2"]: Forged brass or cast bronze construction, tapped 6 mm [¼"] gauge outlet, and integral sight glass.
 - .2 Standard of Acceptance: Victaulic TestMaster II or NFE model A61
- .8 Alarm, Dry Pipe Valves:
 - .1 ULC listed for automatic fire suppression sprinkler systems.
 - .2 Standard of Acceptance: FireFlex, Grinnell, Victaulic NXT Series, Viking. -
- .9 All valves shall be ULC listed for fire suppression systems.
- .10 Required air pressure for dry valves shall be 90 kPa [13 psig].
- .11 All grooved end valves shall be of one manufacturer. Acceptable products: Victaulic.
- .12 Valves shall be externally resettable.
- .13 Valve internal components shall be replaceable without removing the valve from the installed position.
- .14 All drain valves shall be provided with hose end adaptors complete with caps and chains, and auxiliary drains shall be provided with a drum drip.

2.4 SPRINKLERS - GENERAL

- .1 The responsibility for allowing for all sprinklers for a complete installation is to be included in this Section of the work within the base tender price.
- .2 The layout on the drawings shows the general intention of the work and sprinkler locations with respect to other ceiling elements such as ceiling tiles, lights, and diffusers. The Contractor shall provide all additional sprinklers as may be required.
- .3 No extra cost will be considered based on failure of the Contractor to allow for extra sprinklers as required during construction to conform to all NFPA requirements and the Authority Having Jurisdiction, whether shown on the drawings or not.
- .4 Include sprinklers in concealed spaces containing exposed combustible construction including exposed wood beams, exposed wood framing and exposed wood ceiling materials.

2.5 SPRINKLERS - SPECIFIC

- .1 Standard of Acceptance: Viking
- .2 The sprinkler head body shall be die-cast with a glass bulb type activator.

- .3 The body shall be integrally cast with a hex-shaped wrench boss to reduce the risk of damage during installation.
 - .1 Wrenches shall be provided by the sprinkler manufacturer that directly engage the hex-shaped wrench boss in the sprinkler body.
- .4 Sprinklers with rubber O-rings are not permitted,
- .5 All sprinklers shall be ULC listed for use in the occupancies in which they are to be installed.
- .6 All sprinklers shall be quick response unless stated otherwise.
- .7 All sprinklers shall be for commercial applications unless stated otherwise.
- .8 Sprinkler Head Types:
 - .1 Upright, brass:
 - .1 plain brass, quick response, glass bulb in unfinished mechanical and service rooms without ceilings.
 - .2 Upright chrome:
 - .1 chrome plated, quick response, glass bulb in finished rooms and spaces without ceilings such as atriums, skylights and sprinklered exterior covered areas.
 - .3 Pendent, recessed:
 - .1 quick response, glass bulb, chrome plated finish on sprinklers and escutcheons in all finished areas with ceilings except noted below.
 - .4 Pendant, concealed:
 - .1 quick response, chrome plated flat cover plate, at locations including main entrances, foyers, new dryland training, halls, and other similar locations.
 - .5 Horizontal Sidewall, recessed:
 - .1 recessed, quick response, glass bulb, chrome plated finish on sprinklers and escutcheons
 - .6 Horizontal Sidewall, extended throw:
 - .1 recessed, glass bulb, quick response, chrome plated finish on sprinklers and escutcheons
 - .7 Horizontal Sidewall, dry:
 - .1 recessed, glass bulb, quick response, chrome finish on sprinklers and escutcheons
 - .8 Intermediate and high temperature
 - .1 provide in electrical rooms and other required locations as per NFPA 13, complete with wire guards.
- .9 All sprinklers in exposed areas subject to viewing by the occupants of the building shall be in chrome plated finish with chrome plated escutcheons.
- .10 All sprinklers in service spaces, mechanical and electrical rooms, and other spaces subject to view by the maintenance staff of the building only may be in natural plain brass finish.
- .11 Escutcheon plates shall allow accessible (T-bar) ceilings to be removed without removing sprinklers.
 - .1 Construction shall consist of a cup and skirt, the cup being the portion retaining the sprinkler and the skirt being the removable portion around the exterior perimeter of the cup that covers the tile hole.
 - .2 The finished escutcheon installation shall not project more than 4 mm [1/4"] below the finish ceiling surface.

- .3 Recessed two-piece escutcheons and single piece escutcheons that are specifically manufactured with sprinklers to permit escutcheon and ceiling tile removable without sprinkler removal are acceptable.
- .4 The escutcheons shall match the sprinkler finish, be of the same manufacturer as the sprinkler and shall coordinate with architectural features of the building.
- .12 Provide wire sprinkler guards in areas such as mechanical rooms, service rooms, exterior locations, where heads are located less than 2.1m [7'] from floor, etc. where sprinklers are susceptible to mechanical damage or vandalism.
- .13 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.6 FLOW SWITCHES

- .1 ULC listed flow switches suitable for 24 VDC, each with one set of normally open and one set of normally closed contacts, time delay feature and paddle indicator specifically chosen and ULC listed for the size of pipe in which the flow switch is mounted.
- .2 Flow switch test and drain assembly immediately downstream of each flow switch in addition to normal inspector's test connections required by NFPA-13 requirements.
- .3 Flow switches shall be manufactured specifically for use in sprinkler systems rated a minimum 1210 kPa [175 psig], and higher pressure where required.

2.7 PRESSURE SWITCHES

- .1 ULC listed pressure switches where shown on drawings. Pressure switches shall be suitable for 24-VDC contact rating unless otherwise specified, rated a minimum 1210 kPa [175 psig], and higher pressure where required.

2.8 SUPERVISORY SWITCHES

- .1 ULC listed supervisory switches, Potter complete with "J" hooks (on gate valves of OS&Y type) Potter PIVS-C (on NRS valves) or "Potter" BF (on butterfly valves) complete with 1 set of normally open contacts and 1 set of normally closed contacts, or 2 sets of SPDT contacts.
- .2 Switches shall be suitable for 24-volt DC contact rating unless otherwise specified, rated a minimum 1210 kPa [175 psig], and higher pressure where required.
- .3 Looped cable devices are not acceptable.
- .4 Approved valves with integral and/or factory installed indicators and supervisory controls are acceptable products.

2.9 AIR COMPRESSORS

- .1 Provide air compressors for the capacity as determined by the hydraulic calculation design of the dry sprinkler systems.

2.10 SPARE SPRINKLERS

- .1 Provide a red baked enamel steel cabinet containing a minimum of 2 spare sprinklers of each pattern, but in addition, not less than the following of all types:
 - .1 Systems less than 300 heads: 6 spare heads minimum

Part 3 Execution

3.1 WATER SUPPLY CONNECTIONS

- .1 If the water supply connections are in place prior to the commencement of this scope of work, connect to and adapt to the water supply connections and provide all required material and size adapters, offsets, fittings, tie rods, thrust blocks, seismic restraints, and other provisions for a complete installation.

3.2 FIRE SUPPRESSION SPRINKLER SYSTEMS

- .1 Refer to Section 21 05 00 Common Works, Quality Assurance, for requirements related to retaining the services of a Supporting Professional Fire Protection Engineer.
- .2 Supply and install fire suppression sprinkler systems throughout the area of work, in accordance with the listed codes, bylaws, standards and approvals including NFPA-13 and the provincial Building Code and Local Building By-Laws.
- .3 Fire suppression sprinkler system piping within the area of work shall generally be concealed except where specifically noted to be exposed.
- .4 Test sprinkler systems to listed requirements and furnish a certificate stating that such testing has been carried out and approved.
- .5 Provide inspector's test valves and drains at all remote points in the system to NFPA - 13 requirements.
- .6 Install piping to maximize headroom in all areas, including areas without ceilings where the piping is exposed, without interfering with other systems.
- .7 All sprinkler heads shall be new prior to being installed. The use of previously used sprinkler heads is prohibited.
- .8 Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
- .9 Locate sprinklers in general conformance with the locations shown on the sprinkler design drawings.
 - .1 For exact locations refer to the architectural reflected ceiling plans. In the absence of reflected ceiling plans sprinklers shall be installed at the centre point, quarter point and/or third point in the long dimension of ceiling tiles, and in the center point of the short dimension of ceiling tiles, and/or in line with other ceiling elements, light fixtures, diffusers, audio devices and other fittings, in a symmetrical and aesthetic pattern acceptable to the Architect.
 - .2 Coordinate the sprinkler layout with architectural, structural, electrical, and mechanical HVAC ceiling elements.
 - .3 The Victaulic Vic-Flex multiple use flexible stainless steel drop system may be used to properly locate sprinkler heads.
 - .1 The drop system shall be supplied with required supporting members and bracing.
- .10 Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.
- .11 At substantial completion, and a minimum of 10 working days prior to the scheduled Occupancy date, submit Letters of Assurance: Assurance of Professional Field Review and Compliance' to the Consultant and to the local Authority Having Jurisdiction in accordance with the provincial Building Code and Local Building By-Laws.

- .12 Submit to the Consultant a completed Contractor's Material and Test Certificate for all fire suppression systems, and a provide copy in the project Mechanical Operation and Maintenance Manuals.
 - .1 All sections of the forms must be filled in completely and accurately and signed by the applicable persons.
 - .2 In addition to their signatures, their names must be legibly printed on each form.

3.3 PIPE AND FITTINGS

- .1 All welding shall be done in the shop using welding fittings. Field welding is not permitted.
- .2 Flanged pattern fittings shall be used for piping 200 mm [8"] diameter and larger, and at valve stations and fire department connections.
- .3 Provide ULC listed expansion joints or flexible joint fitting assemblies at building expansion joints, building earthquake joints, building firewalls and all other locations as necessary.
- .4 All grooved end components including valves, fittings, gaskets, and couplings shall be of one manufacturer and shall be installed in accordance with the manufacturer's instructions.
- .5 The grooved coupling manufacturer's factory trained representative shall provide on-site training for the Contractor's field personnel in the use of grooving tools and installation of grooved joint products.
 - .1 The representative shall periodically visit the jobsite and review that the Contractor is following their recommended practices in grooved product installation.
 - .2 Roll and cut grooves shall be made in conformance with the fitting manufacturer's written Standard Groove Specifications and within the listed dimensional tolerances.
 - .3 The Contractor shall measure the groove dimensions and adjust the grooving machine rollers and cutters on a regular basis to ensure all grooves are within the manufacturer's written dimensional tolerances.
- .6 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.
- .7 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.

3.4 FLUSHING OF SPRINKLER SYSTEMS

- .1 Flush piping with water until effluent is clear and free of debris.
- .2 Rate of flushing flows shall be as indicated in NFPA-13.
- .3 Provide proper drainage for this flushing operation.

3.5 FLOW SWITCHES

- .1 Provide tight pipe drain connections from test valves to open discharge at floor drains, service sinks, or other discharge points acceptable to the Owner or the Consultant.
- .2 Conduct tests in conjunction with Division 26/27/28 Electrical on each device to ensure the indication of an "alarm" signal and the correct location and labeling thereof on the fire alarm system.

3.6 SUPERVISORY SWITCHES

- .1 Install supervisory switches on all valves supplying the fire suppression sprinkler systems inside the building perimeter.
- .2 Conduct tests in conjunction with Division 26/27/28 Electrical on each device to ensure the indication of a "supervisory" signal and the correct location and labeling thereof on the fire alarm system.

3.7 SYSTEM DEMONSTRATIONS

- .1 Refer to Section 20 05 06 re system demonstration requirements.

3.8 ELECTRICAL EQUIPMENT PROTECTION FROM WATER

- .1 Sprinkler piping and sprinklers are to be installed in various areas containing electrical equipment as shown on the drawings.
- .2 Responsibility for water damage to electrical equipment in these areas from the sprinkler system installation whether due to testing or leakage prior to the Owner's acceptance of the building shall be the responsibility of this Section.
- .3 Provide and install in this Section of the work minimum 20-gauge sheet metal protective hoods individually located over all electrical equipment susceptible to water damage upon release of sprinklers in electrical areas.
 - .1 Such electrical equipment shall include all transformers, all equipment with ventilation grilles and all other switchgear with openings that will allow water entry into the electrical equipment.
 - .2 Protective hoods shall be sloped to allow shedding of water and shall project horizontally beyond the equipment perimeter and shall not be integrally mounted on the equipment unless prior approval has been obtained from the electrical authorities.
 - .3 Holes through protective hoods that cannot be avoided as in the case of traversing electrical conduit shall be sealed with an appropriate waterproof sealing compound.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides General, Product, and Execution Requirements for Fire Extinguishers.
- .2 Provide all required Fire Extinguishers as indicated, including, but not limited to:
 - .1 Multipurpose Dry Chemical Fire Extinguishers
 - .2 Special K Fire Extinguishers
 - .3 Fire Extinguishers cabinets

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 21 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 21.
- .4 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Fire Suppression Systems - Division 21
- .5 Coordinate the work of this Section with the HVAC trades, plumbing trades, electrical trades, and ceiling trades.

1.3 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 Installation, execution, and testing shall conform to the following standards:
 - .1 Provincial Building Code
 - .2 Local building by-Laws
 - .3 Fire protection equipment and installation shall be approved by local Fire Commissioner.
 - .4 National Fire Protection Association NFPA 10 - Standard for Portable Fire Extinguishers.

1.4 QUALITY ASSURANCE

- .1 Refer to Section 20 05 00 General Mechanical Provisions, Quality Assurance for additional details.
- .2 Fire protection equipment and installation shall be approved by local Fire Commissioner.

1.5 SUBMITTALS

- .1 Comply with Section 21 05 00 Common Work for Fire Suppression Systems, Submittals
- .2 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 21 Fire Suppression.

- .3 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 1 and Section 20 05 05 Documentation and Submittals.
 - .2 Shop drawings are required for all materials and equipment.
 - .3 Submit shop drawings for the following items, including but not limited to:
 - .1 Fire Extinguishers
 - .2 Fire Extinguisher Cabinets
- .4 Record Drawings
 - .1 Refer to Division 1 and Section 20 05 05 Documentation and Submittals.
- .5 Occupancy Documentation Requirements
 - .1 Refer to Division 1 and Section 20 05 05 Documentation and Submittals.

Part 2 Products

2.1 STANDARD OF ACCEPTANCE:

- .1 Refer to Section 21 99 65 for Acceptable Manufacturers.

2.2 FIRE EXTINGUISHERS GENERAL:

- .1 All fire extinguisher assemblies shall be as per the following:
 - .1 Cabinets as indicated in the following clauses.
 - .2 Fully rechargeable
 - .3 Steel cylinder with bottom skirt
 - .4 Polyester powder coat finish
 - .5 Waterproof gauge
 - .6 Stainless steel or aluminum valve body and rivets, and gauge
 - .7 Handles with polyester powder coat finish,
 - .8 Steel pull pin
 - .9 Service info tag, hose strap, hose, and nozzle
 - .10 As applicable, meet or exceed requirements of
 - .1 CAN/ULC-S504 Multipurpose Dry Chemical Extinguishers
 - .2 CAN/ULC-S 508-02-R13 Standard for The Rating and Fire Testing of Fire Extinguishers
 - .3 NFPA 10 Standard for Portable Fire Extinguishers
 - .4 NFPA 17 Standard for Dry Chemical Extinguishing Systems

2.3 FIRE EXTINGUISHER FE-1

- .1 Cabinet, fully recessed:
 - .1 203 mm [8"] wide x 432 mm [17"] high x 127 mm [5"] deep fully recessed cabinet with 6mm [1/4"] turnback frame for minimum 127 mm [5"] wall thickness
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners

- .4 Gray baked enamel finish that can be used for either prime coat for field painting, or final finish.
- .2 Extinguisher:
 - .1 kg [5 lb.] dry chemical, multipurpose 2-A:10-B:C

2.4 FIRE EXTINGUISHER FE-2

- .1 Fully recessed cabinet with 2.3 kg [5 lb.] Type K liquid agent fire extinguisher specifically designed for use on fires that involve combustible cooking vegetable or animal fats in commercial cooking equipment multipurpose dry chemical fire extinguisher
- .2 Cabinet:
 - .1 203 mm [8"] wide x 432 mm [17"] high x 127 mm [5"] deep fully recessed cabinet with 6mm [1/4"] turnback frame for minimum 127 mm [5"] wall thickness
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners
 - .4 Gray baked enamel finish that can be used for either prime coat for field painting, or final finish.
- .3 Extinguisher:
 - .1 kg [5 lb.] Purple K
 - .2 Rating: 30B:C
 - .3 Exposed wall hung, Type K portable handheld fire extinguishers specifically designed for use on fires that involve combustible cooking vegetable or animal fats in commercial cooking equipment
 - .4 Type K contains potassium carbonate, potassium acetate, or potassium citrate
 - .5 Wide angle, soft discharge spray pattern, stainless-steel bourdon tube gauge, stainless steel pick-up tube and strainer, heavy chrome plated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install fire extinguishers in cabinets at locations as indicated on the drawings.
- .2 Coordinate locations of fire extinguisher cabinets with the framing trades in order to facilitate recessed and semi-recessed installations.
- .3 Mount fire extinguishers and cabinets such that the top of the extinguisher is at 1,220 mm [4 feet] above the floor.
- .4 Install fire extinguisher cabinet doors, glazing panels and fire extinguishers in the cabinets prior to the project substantial completion review by the Consultant.

3.2 IDENTIFICATION

- .1 Identify fire extinguishers in accordance with the recommendations of NFPA 10.
- .2 Attach a tag or label to all fire extinguishers, indicating the month and year of installation, with space for recording subsequent service dates.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides Product Requirements to indicate manufactures that are generally acceptable for bidding on the project.
- .2 The named manufacturers shall comply with all specific requirements of the Project, as well as details and performance as indicated by the Standard of Acceptance named in the individual specification sections and the equipment schedules.
- .3 Where a manufacturer's name below is underlined>, that manufacturer is generally used as the Basis of Design.
- .4 Refer to Specification Section 20 05 00 General Mechanical Provisions for details regarding Standard of Acceptance, Addition of Acceptable Manufacturers, and Alternate Materials and Equipment.
- .5 Shop Drawings are required to be submitted for all equipment.
- .6 This section refers to Division 21 only. Each Mechanical Division (20, 21, 22, 23, and 25) contains a similar section for equipment that falls under that division.
 - .1 For General Mechanical refer to section 20 99 65
 - .2 For Plumbing and Medical Gas Systems refer to section 22 99 65
 - .3 For HVAC items refer to section 23 99 65
 - .4 For Instrumentation and Controls items refer to section 25 99 65

Part 2 Products

2.1 ACCESS DOORS – BUILDING SURFACES

- .1 Specification Section 20 05 33
- .2 Acudor, Maxam Metal, Milcor, Cendrex, Elmdoor

2.2 CABINETS, HOSE & HOSE VALVES

- .1 Specification Section 21 12 00
- .2 NFE, Larsons, Wilson & Cousins

2.3 FIRE EXTINGUISHERS

- .1 Specification Section 21 25 00
- .2 NFE, Larsons, Wilson & Cousins, Flag

2.4 FIRE EXTINGUISHER CABINETS

- .1 Specification Section 21 25 00
- .2 NFE, Larsons, Wilson & Cousins

2.5 FIRE SUPPRESSION SPRINKLERS

- .1 Specification Section 21 13 00
- .2 Reliable, Grinnell, Viking, Victaulic

2.6 INSULATION – FIRE WRAP

- .1 Specification Section 21 07 13
- .2 3M

2.7 PIPE FITTINGS & COUPLINGS – GROOVED END

- .1 Specification Section 20 12 00 and 21 13 00
- .2 Victaulic

2.8 SEISMIC RESTRAINTS

- .1 Refer To Division 20

2.9 EXPANSION FITTINGS AND JOINTS

- .1 Specification Section 20 20 40
- .2 Mason, Flexonics

2.10 FLEXIBLE PIPE CONNECTORS

- .1 Specification Section 20 20 40
- .2 Mason, Victaulic

2.11 FLEXIBLE DUCT CONNECTORS

- .1 Refer to Specification Section 23 99 65

2.12 PIPE GUIDES AND ANCHORS

- .1 Specification Section 20 05 29
- .2 Grinnell

2.13 FIRE STOPPING

- .1 Specification Section 20 05 31
- .2 Hilti; 3M

2.14 PRESSURE GAUGES

- .1 Liquid - Dial
 - .1 Specification Section 20 05 19
 - .2 Marsh, Weksler, Terrice, Ashcroft

2.15 HEAT TRACING

- .1 Specification Section 20 20 33
- .2 Raychem Chemelex Auto Trace

Part 3 Execution

3.1 NOT APPLICABLE.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides General, Product, and Execution Requirements for Common Work for Plumbing Systems (Division 22).
- .2 The Plumbing Contractor shall retain the services of a Contractor's Supporting Professional Seismic Engineer (Delegated Design) registered in the province where the project is located
 - .1 This Seismic Engineer shall provide complete engineering design and field review services for all seismic restraints.
 - .1 Refer to "Document Submittals" for additional information.
- .3 Provide all Plumbing Systems throughout the buildings as indicated, including, but not limited to the following:
 - .1 Domestic cold, hot and recirc water systems.
 - .2 Sanitary and storm sewer systems
 - .3 Natural gas
 - .4 Plumbing fixtures and trim

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 22 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 22.
- .4 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Plumbing Systems - Division 22
 - .4 Controls and Instrumentation - Division 25
 - .5 Electrical - Division 26/27

1.3 SEISMIC PROTECTION

- .1 Refer to Section 20 05 49 Seismic Restraints.

1.4 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 All equipment, installation, and testing shall conform to the following standards as a minimum:
 - .1 Provincial Building Code
 - .2 Local Building By-Laws
 - .3 ASME/ANSI B31.9 Building Services Piping
 - .4 CSA B149.1, Natural Gas and Propane Installation Code

.5 Provincial Gas and Safety Branch Bulletins

1.5 LEAD-FREE COMPLIANCE

- .1 All pipe, pipe fittings, valves, faucets, accessories, or any other system components that contact drinking water shall be certified as "lead-free" as required by NSF-372, and NSF 61 Annex G Section 9.

1.6 QUALITY ASSURANCE

- .1 Refer to Section 20 05 00 General Mechanical Provisions, Quality Assurance for additional details.
- .2 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
- .3 Installation shall be in accordance with well-established practice and standards accepted and recognized by the Consultant and the Trade.
- .4 The Consultant shall have the right to reject any item of work that does not conform to the Contract Documents and accepted standards of performance, quietness of operation, finish, and appearance.
- .5 Employ only Tradespeople holding valid Provincial Trade Qualification Certificates.
- .6 Temporary Usage of Plumbing Equipment
 - .1 Plumbing equipment and systems shall not be used without the written permission of the Design Authority and in no circumstances shall be used prior to testing and inspection.

1.7 COORDINATION

- .1 Systems indicated in Division 22 sections, located inside and/or buried beneath and/or on the roof of the building shall extend to a point 900 mm [36"] beyond the exterior face of the building.
- .2 Plumbing drawings are diagrammatic and approximately to scale.
 - .1 They establish the scope of the work and the general location and orientation of the plumbing systems.
 - .2 The systems shall be installed generally in the locations and generally along the routings shown, close to the building structure and coordinated with other services.
 - .3 Piping shall be concealed within walls, ceilings or other spaces and shall be routed to maximize head room and the intended use of the space through which they pass, unless specifically noted otherwise.

1.8 SUBMITTALS

- .1 Comply with Division 01 and Section 20 05 05 Documentation and Submittals.
- .2 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 22.
- .3 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 01 and Division 20 05 05 Documentation and Submittals.
 - .2 Shop drawings are required for all materials and equipment.

- .4 Product Options and Substitutions
 - .1 Refer to Section 20 05 00, for requirements pertaining to product options and substitutions.
- .5 Samples
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Provide samples as indicated.
- .6 Maintenance Data
 - .1 Refer to Division 01 and Division 20 05 05 Documentation and Submittals.
 - .2 Submit manufacturer's recommended maintenance tasks for a one-year period. Include maintenance schedules and lubrication products.
 - .3 Refer to the following clause "Record Drawing" for additional information.
- .7 Record Drawings
 - .1 Refer to Division 01 and Division 20 05 05 Documentation and Submittals.
 - .2 Provide project "As-Built" Record Drawings for all plumbing systems.
 - .3 In addition, as a minimum, during the construction period,
 - .1 Keep on site a clean set of drawings marked up, IN COLOUR, to reflect the 'As-Built' state, for examination by the Consultant on a regular basis.
 - .2 Include elevations, rough-in details, and detailed locations of all hidden services, including locations of maintenance items and their associated identification code (ie. valves).
 - .3 All concealed (above grade and below grade) services shall be dimensionally located and noted, (use gridlines or structure as the reference).
 - .4 Provide invert elevations for all below grade services.
 - .4 At the time of 'Substantial Performance', submit to the Consultant one complete full-sized COLOUR hard copy of all Record Drawing information produced as per the above section.
 - .5 The Record Drawings produced shall be based on the IFC drawings and any updates (addendums, change orders, site instructions, field directives, etc) that have been issued.
 - .6 Submit signed and sealed copies of Record Drawings, Final Design Drawings and As-built Drawings as requested by the project Architect, Certified Professional (C.P.), Authority Having Jurisdiction and the Consultant.
 - .7 Submit hard copies of all As-Built record drawings for inclusion in the hard copy maintenance manual.
 - .8 Provide digital files in PDF format for inclusion in the digital format manuals and submit files directly to the consultant.
 - .1 Provide one PDF file for each drawing file produced.
 - .9 Transfer the Record Drawing mark-ups digitally using AutoCAD and by creating As-Built record drawings "DWG" files.
- .8 Occupancy Documentation Requirements
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.

1.9 PENETRATING WATERTIGHT STRUCTURE

- .1 Provide water stops, link seals, and anchor flanges for all piping penetrating lower-level floors, exterior walls, etc., where water penetration may occur.

1.10 BUILDING OPERATION DURING CONSTRUCTION

- .1 To minimize operational difficulties for the building's staff, the Contractor shall cooperate with the Owner throughout the entire construction period and particularly ensure that noise and dust is minimized.
 - .1 Provide hoarding as deemed necessary and instructed.
- .2 Convenient access for the staff and public to the building must always be maintained.
 - .1 Minor inconvenience and interruption of services will be tolerated, provided advance notice is given to the Owner.
 - .2 The Contractor is expected to coordinate his work, in consultation with the Owner, so the operation of the facility can be maintained as nearly normal as possible.

1.11 EXISTING SERVICES

- .1 Protect all existing services encountered.
 - .1 Every effort has been made to show the known existing services. However, the removal of concealing surfaces may reveal other existing services.
 - .2 Work with the Owner's staff to trace the originating source and points served.
 - .3 Obtain instructions from the Consultant when existing services require relocation or modifications, other than those already indicated in the Contract Documents.
- .2 Arrange work to avoid shutdowns of existing services.
 - .1 Where shutdowns are unavoidable, obtain the Owner's approval of the timing, and work to minimize any interruptions.
- .3 In order to maintain existing services in operation, temporary relocations and/or bypasses of piping may be required.
- .4 Be responsible for any damages to existing system by this work.
- .5 The Owner reserves the right to withhold permission for a reasonable period with respect to any shutdown, if shutting off a service will interfere with important operations.

1.12 EXISTING PIPING AND EQUIPMENT TO BE REMOVED

- .1 All existing plumbing equipment and piping systems that become obsolete because of the work depicted on the drawings, or as indicated for abandonment, shall be removed, and disposed of if the Owner declines to retain, in the following situations:
 - .1 Where specifically noted on the drawings for removal.
 - .2 Where plumbing piping systems are exposed.
 - .3 Where ceilings are opened-up for any reason that would permit such removal to be implemented.
 - .1 In such a case only those portions of the plumbing equipment and systems that can be removed without taking down more ceiling shall be removed.
 - .4 If the Owner wants to retain the equipment or piping, move to a location as identified by the Owner.

1.13 ACOUSTICAL TREATMENT

- .1 The contractor shall consider equipment selection and pay close attention to detail during the rough-in stage to assure maximum acoustical provisions have been made.
- .2 The insulation for wall, ceilings and pipe chases as outlined herein is to be provided and installed under another division of work.

- .1 This section is responsible for ensuring that all special requirement for plumbing systems have been met before the wall or ceilings have been closed in.
- .3 General Scope of Work
 - .1 All plumbing systems located in any walls or within 2 metres [6½'] in any direction of the enclosing walls of the following areas (or of similar areas not specifically named) shall be especially protected against noise transmission as defined herein:
 - .1 Private offices.
- .4 Summary of Requirements
 - .1 Drain, Waste and Vent Stacks and Rainwater Leaders:
 - .1 Cast iron pipe and mechanical or neoprene compression gasket hub fittings shall be used.
 - .1 Plastic and copper piping are unacceptable.
 - .2 Waste piping over sound sensitive areas shall be insulated with pre-formed glass fiber insulation.
 - .2 Stubs from appliances in the kitchens or lounge areas may be copper, but a minimum length should be used.
 - .3 Waste connections from appliances and fixtures may be copper to the waste stack.
 - .4 All copper dry vent pipes in walls, chases and ceiling plenums shall be lagged with 25 mm [1"] preformed glass fiber pipe insulation, canvas wrapped and sealed airtight and with one or more coats of heavy enamel paint.
 - .5 Rainwater leader chases shall be airtight and contain non-compressed RSI 2.11 [R-12] glass fibre insulation in the stud cavities.
 - .2 Domestic Water Operating Parameters:
 - .1 The maximum pressure at any faucet or outlet shall be 275 kPa [40 psig] with at least 10% of maximum rated flow through any pressure reducing valve in the system.
 - .3 Pipe Sizes:
 - .1 The minimum pipe size to faucets or mixing valves of each fixture shall be 12 mm [½"].
 - .1 The use of 9 mm [¾"] pipes is prohibited.
 - .4 Plumbing Fixtures and Trim:
 - .1 Mixing Valves and Faucets:
 - .1 Quiet cartridge shall be used at mixing faucets and shower valves.
 - .2 Any which subsequently become noisy during the warranty period shall be replaced at no extra charge to the owner.
 - .2 Back-to-back Fixtures:
 - .1 Drain line and water supply lines shall be divided at the riser.
 - .2 Tee takeoffs serving back-to-back fixtures are not permitted.
 - .3 Quick Acting Valves:
 - .1 All solenoid operated, or other quick acting valves shall be equipped with water hammer arresters located as close to the valves as possible.
 - .5 Fastening to the structure:
 - .1 Piping shall not contact any framing stud or wall surface; or any other conduit, electrical or ventilation fixture that is connected to any wall or ceiling surface.

- .2 Piping shall not be fastened to a partition which forms part of an adjacent room not served by the pipe in question.
 - .1 Do not secure piping to gypsum wallboard or its supporting frame.
- .3 Riser clamps shall be isolated from the structure using an approved resilient material between the support collar and the floor structure (Vibro-Acoustics type SN, 30 durometer, 57.15 mm [2¼"] x 57.15 mm [2¼"] in size, or an approved equal).
 - .1 An alternate method is to wrap the pipe with neoprene prior to clamping.
- .4 Pipe hangers shall be oversized to suit the insulation and shall have a protection shield between the insulation and the hanger.
- .5 Pipe hangers shall contain 50 durometer, 3.2 mm [1/8"] thick neoprene pads inserted between the hanger saddle and pipe.
- .6 Clearance Around Pipes:
 - .1 All pipe (bare or insulated) shall be clear of contact with studs or gypsum wallboard.
 - .2 Pipes in acoustically critical walls shall be wrapped with a minimum thickness of 6 mm [¼"] of Armaflex or Rubatex sleeving and secured by use of oversized clamps.
 - .1 This is not necessary where the piping is insulated if pipe clamps are mounted around the exterior of the insulation.
 - .2 Hard plastic pipe sleeves shall not be used.
- .7 Wall and Slab Penetration by Pipes:
 - .1 Slab penetrating pipes shall be glass fiber wrapped prior to grouting. The grout shall not contact pipes.
 - .2 Gypsum wallboard or plaster wall pipe penetrations shall be 3 mm [1/8"] to 6 mm [¼"] oversized with the pipe centred in the hole and the gap caulked with silicone or other non-hardening sealant.
 - .3 Pipe expansion joints shall be for noise free operation.
- .8 Ceiling, Wall and Other Plumbing Pipe Chases:
 - .1 The interior spaces shall be insulated with non-compressed RSI 2.11 [R-12] batt insulation in the following proportions:
 - .1 Ceiling plenum - 80% of area.
 - .2 Chases - 100% of all four vertical surfaces.
 - .3 Walls - 50% of space containing pipe, and 100% of adjacent stud space.

1.14 MISCELLANEOUS METAL RELATED TO PLUMBING SYSTEMS

- .1 Refer to Section 20 05 00 General Mechanical Provisions.

1.15 CUTTING, PATCHING, DIGGING, CANNING, AND CORING

- .1 Refer to Section 20 05 00 General Mechanical Provisions.

1.16 MISCELLANEOUS METALS

- .1 Refer to Section 20 05 00 General Mechanical Provisions.

Part 2 Products

2.1 PRODUCT CONSISTENCY

- .1 All products utilized on the project shall be as per the shop drawing submissions.
- .2 All products of a similar nature used in a similar system or application shall be of the same manufacturer throughout the project.

2.2 HANGERS AND SUPPORTS

- .1 Refer to section 20 05 29 for Hangers, Supports, and Anchors.

2.3 PIPE SLEEVES AND ESCUTCHEONS

- .1 Refer to Section 20 05 31 Penetrations, Flashings, and Seals.

2.4 CLEANOUTS

- .1 Refer to section 22 13 00 Sanitary and Storm Drainage.

2.5 ACCESS DOORS

- .1 Refer to Section 20 05 33 Access Doors.

2.6 SERVICE PENETRATIONS IN RATED FIRE SEPARATIONS

- .1 Refer to Section 20 05 31 Penetrations, Flashings, and Seals.

2.7 SERVICE PENETRATIONS IN NON-RATED FIRE SEPARATIONS

- .1 Refer to Section 20 05 31 Penetrations, Flashings, and Seals.

2.8 FIRE STOPPING AND SMOKE SEAL MATERIALS

- .1 Refer to Section 20 05 31 Penetrations, Flashings, and Seals.

Part 3 Execution

3.1 PIPING INSTALLATION

- .1 General:
 - .1 Install piping straight, parallel, and close to walls and ceilings, with a downward slope of not less than 1:100 for gravity piping and with a slope to drain cocks, fixtures or equipment for all pressure piping unless otherwise indicated on drawings.
 - .1 Use industry standard fittings for direction changes.
 - .2 Provide drain cocks as required.
 - .2 Install groups of piping parallel to each other; spaced to permit application of insulation, identification, and service access, on trapeze hangers.
 - .3 Where pipe size differs from connection size to equipment, install reducing fitting close to equipment.
 - .1 Reducing bushings are not permitted.
 - .4 Brass and copper pipe and tubing shall be free from surface damage.
 - .1 Replace damaged pipe or tubing.

- .5 Ream ends of pipe and tubes before installation.
- .6 Lay copper pipe so that it is not in contact with dissimilar metal and will not be crimped or collapsed.
 - .1 All joints on cast or ductile iron pressure service piping shall be made electrically conductive.
- .7 Install flanges or unions to permit removal of equipment without disturbing piping systems.
- .8 Clean ends of pipes or tubing and recesses of fittings to be jointed.
 - .1 Assemble joints without binding.
- .9 Install piping to connections at fixtures, equipment, outlets, and all other appurtenances requiring service.
- .10 Grade all vents to drain back to waste piping.
- .11 Plug or cap pipe and fittings to keep out debris during construction.
- .12 Jointing of pipe shall be compatible with type of pipe used.
- .13 Non-corrosive lubricant or Teflon tape shall be applied to the male thread of threaded joints.
- .14 Flush and clean out piping systems after testing.
- .2 Equipment Drainage:
 - .1 Install drain valves with caps and chains at low points.
 - .2 Extend equipment drain piping to discharge into floor or hub drain.
- .3 Expansion and Contraction and Building Seismic Joints:
 - .1 Support piping to prevent any stress or strain.
- .4 Install pressure piping with loops and offsets which will permit expansion and contraction to occur without damaging the pressure piping system.
- .5 Buried Piping:
 - .1 Lay pipe on compacted bedding of clean, coarse sand free from clay, snow or ice, organic matter, or stones.
 - .2 Do not lay pipe in water or when conditions are unsuitable.

3.2 ACCESS DOORS

- .1 Refer to Section 20 05 33 Access Doors.
- .2 Install access doors at all concealed cleanouts, traps, unions, expansion joints, valves, control valves, air vents, water hammer arrestors, special equipment, trap primers, vacuum breakers, and any other equipment for which subsequent periodic access will be required.
- .3 Locate access doors so that all concealed items are readily accessible for adjustment, operation, maintenance, and replacement.
- .4 Do not locate access doors in feature walls or ceilings without the prior approval of the Consultant.
 - .1 Locate in service areas and storage rooms wherever possible.

3.3 PIPING EXPANSION

- .1 Refer to Section 20 20 40 Expansion Fittings and Loops

- .2 Install piping with all necessary changes of direction, expansion loops, anchors, and guides so that expansion and contraction will not overstress the piping and equipment piping connections.
- .3 Expansion loops shall be of all welded construction with long radius elbows; cold sprung 50% and located between anchors.
- .4 Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.

3.4 TESTING AND INSPECTION

- .1 Refer to Section 20 05 07 Materials Testing.
- .2 Refer to Section 20 05 08 Equipment Testing.
- .3 Furnish all labour, materials, instruments, etc. necessary for all required tests.
 - .1 All work shall be subject to inspection by local plumbing inspector and review by the Consultant.
 - .2 At least forty-eight (48) business hours (2 business days) notice shall be given in advance of making the required tests for projects within 40 km of the Consultant's Project Office.
- .4 All leaks shall be corrected by remaking the joints.
 - .1 The systems shall be retested until no leaks are observed.
- .5 No plumbing system or part thereof shall be covered until it has been inspected and approved by the Consultant and the Plumbing Inspector.
- .6 If any plumbing system or part thereof is covered before being inspected or approved, it shall be uncovered upon the direction of the Plumbing Inspector or Consultant.

3.5 PROJECT PHOTOGRAPHS

- .1 The Contractor shall provide digital photographs in "jpg" format to the Consultant complete with a text description or each photograph including the date, system type, materials used, and location/direction for all sections of underground piping prior to backfilling.
 - .1 Submit the photographs via email and/or disc as requested by the Consultant.
- .2 Provide additional digital photographs of the work as requested by the Consultant to assist in the resolution of RFIs, prior to covering the work.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides General, Product, and Execution Requirements for insulation on plumbing piping, valves, and tubing.
- .2 Provide piping insulation on all plumbing piping systems as indicated, including, but not limited to
 - .1 Domestic cold water.
 - .2 Domestic hot water and recirculation.
 - .3 Domestic tempered water and recirculation.
 - .4 Storm drainage piping for the full length of the systems located within the building and the underside of roof drain bodies.
 - .5 Sanitary waste and p-traps, and storm drainage systems in exterior and unheated areas (after heat tracing is complete and commissioned).
 - .6 Sanitary vent stacks for the last 3 meters [10 feet] prior to penetrating the roof or penetrating a cold attic or similar space.
 - .7 Offset waste piping, p-traps and supplies under all wheelchair accessible lavatories and sinks.
 - .8 Provide anti-sweat coating where required.
- .3 Include:
 - .1 Insulation
 - .2 Adhesives, tie wires, tapes.
 - .3 Finishing and recovering.

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 22 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all Documentation therein that is applicable to Division 22.
- .4 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Plumbing Systems - Division 22

1.3 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 All installation, execution, and testing shall conform to the following standards as a minimum:
- .3 Insulation thickness and insulating values shall be in accordance with the most stringent of the National Energy Code of Canada for Buildings (NECB), and ASHRAE 90.1.
 - .1 The more stringent insulation value (between the two codes) will be the minimum level required for this project.

- .4 Flame spread ratings and smoke developed classifications shall be as required by the Provincial Building Code and NFPA 90A.
 - .1 Flame Spread / Smoke Development
 - .1 The flame spread/smoke developed index throughout the material shall not exceed the following:
 - .1 Flame Spread Index: 25
 - .2 Smoke Developed Index: 50
- .5 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking, or flaming when tested in accordance with ASTM C411.
- .6 In addition to Section 20 05 01, Division 23 work shall conform to the following codes, regulations and standards, and all other codes in effect at the time of award of Contract, and any others having jurisdiction.
 - .1 National Energy Code of Canada for Buildings (NECB).
 - .2 ASHRAE Standard 90.1 - Energy Standard for Buildings except Low Rise Residential Buildings
 - .3 ASTM C335 - Steady State Heat Transfer Properties of Pipe Insulation.
 - .4 ASTM C411 - Hot-Surface Performance of High Temperature Thermal Insulation
 - .5 ASTM C449 – Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement
 - .6 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation
 - .7 ASTM C547 - Mineral Fiber Pipe Insulation
 - .8 ASTM C552 Standard Specification for Cellular Glass Thermal Insulation
 - .9 ASTM C553 - Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - .10 ASTM C612 - Mineral Fiber Block and Board Thermal Insulation
 - .11 ASTM C1126 (Gr.1) Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation
 - .12 CGSB 51-GP-11M Thermal Insulation, Mineral Fiber, Blanket for Piping, Ducting, Machinery and Boilers.
 - .13 CAN/CGSB-51.2 Thermal Insulation, Calcium Silicate, for Piping, Machinery and Boilers.
 - .14 CAN/CGSB-51.12 Cement, Thermal Insulating and Finishing.
 - .15 CAN/CGSB-51.40 Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
 - .16 CGSB 51-GP-52MA - Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation
 - .17 CAN/CGSB- 51.53 - Poly (Vinyl Chloride) Jacketing Sheet for Insulated Pipes, Vessels, and Round Ducts
 - .18 CAN/ULC- S102 - Surface Burning Characteristics of Building Materials and Assemblies

1.4 **QUALITY ASSURANCE**

- .1 Refer to Section 20 05 00 General Mechanical Provisions, Quality Assurance for additional details.
- .2 Employ only Tradespeople holding valid Provincial Trade Qualification Certificates.

- .3 Be responsible for ensuring that enough space is always provided to allow proper installation of insulation materials.
- .4 Material and method of application to comply with or be tested in accordance with the latest version of the following Insulation Standards Manuals,
 - .1 Provincial Building Code and Local by-laws
 - .2 Master Insulators Association Standards Manual.
 - .3 Insulation Contractors Association Standards Manual.
 - .1 Use the latest edition of the Insulation Standards Manual as the base reference standard if insufficient detail/information is contained herein, or if the Insulation Standards Manual Standard is more stringent.
 - .4 Thermal Insulation Association of Canada (TIAC) National Insulation Standard.
- .5 Work shall be inspected by certified mechanical insulation inspectors who maintain current certification by the National Insulation Association, or other certified mechanical insulation certification Association.
 - .1 Provide the Owner with a Quality Assurance Certificate for the mechanical insulation work at Substantial Completion of the Work.

1.5 SUBMITTALS

- .1 Comply with Division 01 and Section 20 05 05 Documentation and Submittals.
- .2 Comply with Section 22 05 00 Common Work for Plumbing Systems, Submittals
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all Documentation therein that is applicable to Division 22 Plumbing.
- .4 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 01 and Division 20 05 05 Documentation and Submittals.
 - .2 Shop drawings are required for all materials and equipment.
 - .3 Submit, for approval, substantiating manufacturer's Documentation when requested for all materials, applications and finishing methods to establish that all will satisfy this specification and meet all applicable code requirements, before commencing work.
 - .4 Submit product data and test reports indicating that insulation and recovery assemblies meet flame/smoke development indices and performance requirements.
 - .5 Submit, for approval, samples of each type of firestopping, smoke seal and accessory.
 - .6 Submissions (Shop Drawings) and other Documentation shall include all Adhesives and Sealants Material Safety Data Sheets (MSDS) highlighting the materials Volatile Organic Compound (VoC) levels.
 - .7 For each application submit an insulation schedule to include the following information:
 - .1 Materials
 - .2 Flame/Smoke rating
 - .3 "k" Value: Thermal conductivity of insulating material per unit of thickness (W/m.°C).
 - .4 Thickness
 - .5 Density
 - .6 Finish
 - .7 Jacketing

- .8 Submit information showing installed insulation and membrane products meet the requirements of the Model National Energy Code of Canada for Buildings (MNECB) and ASHRAE 90.1.
- .5 Product Options and Substitutions
 - .1 Refer to Section 20 05 00, for requirements pertaining to product options and substitutions.
- .6 Samples
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Submit, for approval, samples of all materials, applications and finishing methods to establish that all will satisfy this specification and meet all applicable code requirements, before commencing work.
- .7 Maintenance Data
 - .1 Refer to Division 01 and Division 20 05 05 Documentation and Submittals.
- .8 °Occupancy Documentation Requirements
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.

Part 2 Products

2.1 ASBESTOS

- .1 All material / products installed shall be free of asbestos.

2.2 FLAME SPREAD RATINGS AND SMOKE DEVELOPED CLASSIFICATIONS

- .1 All material / products installed shall meet the 25/50 indices.

2.3 FIRE STOPPING AND SMOKE SEAL MATERIALS

- .1 Refer to Section 20 05 31 Penetrations, Flashings, and Seals.

2.4 HOT PIPE INSULATION - MINERAL FIBER:

- .1 Standard of Acceptance:
 - .1 Manson Alley K-ASJ
- .2 Service Temperature: 27°C to 150°C.
- .3 Material: Formed rigid mineral fiber insulation sleeving to ASTM C547.
- .4 Jacket: Factory applied general purpose jacket with pressure sensitive self-sealing longitudinal lap.
- .5 Thermal conductivity at 24°C [75°F] – 0.033 W/sq.m/°C [0.23 btu/h/sq.ft/°F]
- .6 Thermal conductivity at 93°C [200°F] – 0.04 W/sq.m/°C [0.28 btu/h/sq.ft/°F]

2.5 HOT PIPE INSULATION - HIGH TEMPERATURE

- .1 Use this type where there is a chance of insulation getting wet.
- .2 Standard of Acceptance:
 - .1 Johns Manville Thermo-12
- .3 Service Temperature: up to 750°C.
- .4 Material: Formed rigid hydrous calcium silicate for piping to ASTM C533.

- .5 Water resistant
- .6 Thermal conductivity at 93°C [200°F] – 0.058 W/m°C

2.6 CALCIUM SILICATE INSULATION - SPRAY GRADE

- .1 Standard of Acceptance:
 - .1 Thermolite SG
- .2 Product for high temperature thermal insulation with super calcium silicate plastic.
- .3 This method is designed especially for large surfaces and irregular shapes such as turbines, boilers, storage tanks and others.

2.7 COLD PIPE INSULATION: - MINERAL FIBER:

- .1 Service Temperature: below 15°C.
- .2 Material: Formed mineral fibre rigid insulation sleeving to ASTM C547.
- .3 Thermal conductivity at 24°C [75°F] – 0.035 W/m°C [0.245 btu/h/sq.ft/°F]
- .4 Jacket: factory applied vapor barrier jacket to CGSB 51-GP-52Ma, Type 1, with longitudinal lap seal.

2.8 ACCESSORIES

- .1 For mineral fibre insulation materials:
 - .1 FSK Tape: Vapor barrier tape consisting of laminated aluminum foil, glass fiber scrim and paper, with pressure sensitive self-adhesive.
 - .2 ASJ Tape: Vapor resistant tape consisting of all-service jacket material with pressure sensitive self-adhesive.
 - .3 Adhesive: Quick setting adhesive for joints and lap sealing.
- .2 Thermal Insulating and Finishing Cement:
- .3 To ASTM C449 mineral fiber hydraulic setting thermal insulating and finishing cement for use up to 650°C.

2.9 RECOVERY JACKETS, FASTENERS, ADHESIVES, AND COATINGS

- .1 Canvas Jacket
 - .1 Fire rated, 6-ounce fire retardant canvas jacket
 - .2 Flame spread and smoke density does not exceed 25/50 per ASTM E84
 - .3 Standard of Acceptance:
 - .1 Robson Flamex FR
- .2 Metal Jacket
 - .1 0.3mm [22 ga] aluminum, smooth finish
 - .2 longitudinal slip joints and 50 mm [2"] end laps
 - .3 factory applied protective liner on interior surface
 - .4 0.3mm [22 ga.] thick, die shaped fitting covers
 - .5 Stainless-steel bands
 - .6 Standard of Acceptance:
 - .1 Johns Manville Metal Jacketing System

- .3 PVC Finishing Jacket
 - .1 minimum 0.50 mm [0.02"] thick, white
 - .2 minimum 0.50 mm [0.020"] thick premoulded one-piece fitting covers.
 - .3 Standard of Acceptance:
 - .1 Proto PVC, Speedline PVC, Zeston PVC.

2.10 FASTENERS, ADHESIVES, AND COATINGS

- .1 General
 - .1 Tape shall be shelf adhesive 100 mm [4"] wide.
 - .2 Contact adhesive shall be quick setting.
 - .3 Lap seal adhesive shall be quick setting for joints and lap sealing for vapor barriers.
 - .4 Adhesive for canvas shall be washable, for cementing canvas to equipment insulation.
 - .5 Steel wire shall be 1.3 mm diameter galvanized anneal.
 - .6 Stainless steel wire shall be 1.3 mm diameter, type 304.
 - .7 Steel brands shall be 19 x 0.4 mm stainless steel.
- .2 Jacket Fastenings:
 - .1 ThermoCanvas and All Service:
 - .1 Stainless-steel staples (flare type)
 - .2 Compatible jacket finishing tape and contact adhesives as recommended by the jacket manufacturer.
 - .2 PVC Jacket and Fitting Covers:
 - .1 PVC self-adhesive tape, plastic pop rivets, bonding cement.
- .3 Adhesives:
 - .1 As recommended by the insulation or jacket manufacturer.
 - .2 Vapour barrier jacket adhesive:
 - .1 Standard of Acceptance:
 - .1 Bakelite 230-39, Childers CP-82, Epolux Cadoprene 400, Foster 85-20.
 - .3 Fabric adhesive, to insulation pipe covering:
 - .1 Standard of Acceptance:
 - .1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36, Robson White Lag.
- .4 Coatings:
 - .1 Vapour barrier coating on reinforcing membrane or on insulating cement:
 - .1 Standard of Acceptance:
 - .1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36.
 - .2 Childers CP-30 (refrigeration suction lines only).
- .5 Reinforcing Membrane:
 - .1 Glass reinforcing membrane as commercially available.
- .6 Insulating Cement:
 - .1 Standard of Acceptance:
 - .1 Fibrex Superkote, Partek No. 1, Ryder Thermokote MW high temperature.

- .7 Finishing Cement:
 - .1 Standard of Acceptance:
 - .1 Ryder Thermokote 1 FW.
- .8 Preformed Insulation fittings:
 - .1 Standard of Acceptance:
 - .1 Shur-Fit, Moulded Acoustic Products or from insulation fabricators.

Part 3 Execution

3.1 DEFINITIONS

- .1 For the purposes of this section, the following definitions apply:
 - .1 Concealed: Piping systems and equipment in trenches, shafts, furring, and suspended ceilings.
 - .2 Exposed: Piping systems and equipment in mechanical rooms or otherwise not "concealed".
 - .1 For greater certainty, the following locations are considered exposed:
 - .1 Services in all mechanical and electrical rooms.
 - .2 Services in tunnels,
 - .3 Services in space beneath raised floors.
 - .4 Trenches located in boiler rooms.

3.2 INSTALLATION GENERAL

- .1 Apply insulation after required piping system tests have been completed, witnessed, and certified.
- .2 Ensure piping surface is clean and dry before insulating.
- .3 Install in accordance with TIAC National Standards, or Provincial Standards.
- .4 Install in accordance with manufacturers recommendations.
- .5 Insulation and vapour barrier shall be continuous through all non-rated separations.
- .6 Locate cover seams in least visible locations.
- .7 Stagger butt joints where multi-layered insulation is used.
- .8 On vertical piping with diameters 25 mm and larger, use insulation supports welded or bolted to pipe directly above lowest pipe fitting.
 - .1 Repeat supports on 4.5 m centers and at each valve and flange.
- .9 Tightly fit insulation sections to pipe to make smooth and even surfaces. Cut insulation for proper fit where weld beads protrude.
 - .1 Bevel away from studs and nuts to allow their removal without damage to insulation.
 - .2 Trim closely and neatly around extending parts of pipe saddles, supports, hangers, clamp guides and seal with insulating/finishing cement.
- .10 Apply insulation and insulation finish in a workmanlike manner so that the finished product is uniform in diameter, smooth in finish, pleasing to the eye and with the longitudinal seams positioned to be concealed from view.
 - .1 Apply piping insulation materials, accessories and finishes in accordance with manufacturer's recommendations.

- .11 On piping 65mm [2-1/2"] and larger with insulation and vapour barrier, install high density insulation above hanger shield. Insert to be slightly longer than the length of shield.
 - .1 Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.
 - .2 Pro-pipe supports by Shur-Fit or equivalent products are acceptable.

3.3 INSULATION TERMINATION POINTS

- .1 Terminate insulation 75 mm [3"] back from all uninsulated fittings to provide working clearance and terminate insulation at 90° and finish with reinforced scrim cloth and vapour barrier mastic system.
 - .1 Cover onto pipe and over the insulation vapour barrier.
 - .2 On concealed hot services terminate insulation 75mm [3"] back from all uninsulated fittings, cut off at 90° and apply reinforced scrim cloth and breather mastic system.
- .2 Cut back insulation at 45° and finish with a silicone caulking sealant around the base of thermometer wells, pressure gauges, flow switches and pressure and control sensors.

3.4 VERTICAL RISERS

- .1 On vertical pipe over 75 mm [3"] provide insulation supports welded or bolted to pipe, directly above lowest pipe fitting. Thereafter, locate on 4.5 m [15 ft.] centres.

3.5 HOT APPLICATION 26°C [80°F] TO 200°C [400°F]

- .1 Piping:
 - .1 Install medium temperature pipe insulation with integral jacket to pipe and hold in place by stapling the flap, with spreading staples at 75 mm [3"] centres.
 - .1 Pipe insulation with integral self-sealing jacket will not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints and secure with spreading staples.
- .2 Fittings:
 - .1 Insulate fittings, to thickness of adjacent pipe insulation, with oversize sections of the pipe insulation mitred to fit tightly, or with preformed insulation fittings (Shur-Fit or equivalent) or from insulation fabricator.
- .3 Valves, Strainers:
 - .1 Insulate valve bodies and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation or insulate with preformed insulation fittings (Shur-Fit or equivalent) or from insulation fabricator.
 - .1 Drains, blowoff plugs and caps shall be left uncovered.
- .4 Flanges and Victaulic Fittings:
 - .1 Insulate flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe insulation.
 - .1 Insulation to overlap adjoining insulation at least 75 mm [3"].
 - .2 Alternatively, use preformed insulation fittings (Shur-Fit or equivalent).

3.6 COLD APPLICATION 10°C [50°F] AND LESS

- .1 Piping:
 - .1 Install low/medium temperature pipe insulation with integral vapour barrier jacket to pipe and hold in place by securing the jacket flap.
 - .1 Seal all flaps with vapour barrier adhesive.
 - .2 Pipe insulation with integral self-sealing vapour barrier jackets will not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive.
 - .1 Over wrap butt strips by 50 percent for insulation O.D. 300 mm [12"] and above apply strips on 250 mm [10"] centres for additional securement.
- .2 Fittings:
 - .1 Insulate fittings to thickness of adjacent pipe insulation with sections of the pipe insulation mitred to fit tightly, or preformed insulation fittings (Shur-Fit or equivalent), then apply reinforcing membrane embedded barrier coating and apply finish vapour barrier coating.
 - .2 Alternatively, insulate fittings with tightly placed flexible insulation and apply premoulded 25/50 rated PVC fitting covers.
 - .1 Apply vapour-barrier adhesive and tape on all joints and overlaps. Demonstrate continuity of vapour barrier.
- .3 Valves, Strainers:
 - .1 Insulate valve bodies, bonnets and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation, then apply reinforcing membrane embedded in barrier coating.
 - .2 Alternately, insulate with preformed insulation fittings (Shur-Fit or equivalent) covered with reinforcing membrane, secured in place with a continuous barrier. Drains, blow-off plugs and caps shall be left uncovered.
- .4 Unions, Flange and Victaulic Fittings:
 - .1 Insulate cold unions and flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe covering, then apply reinforcing membrane embedded in barrier coating and final coating of vapour barrier mastic.
 - .2 Alternately, insulate with preformed insulation fittings (Shur-Fit or equivalent) covered with reinforcing membrane, secured in place and with continuous vapour barrier.

3.7 ANTI-SWEAT COATING

- .1 Coat with an anti-sweat coating - "No Sweat" by Robson Thermal Mfg. Ltd. or approved alternate the following uninsulated cold surfaces:
 - .1 Connecting surfaces of thermometers, pressure gauges, flow switches, controllers, etc.
- .2 The coating thickness shall be as recommended by the coating manufacturer for the system operation conditions.

3.8 PIPE INSULATION FINISHES

- .1 "Concealed" insulation in horizontal and vertical service spaces will require no further finish.
- .2 "Concealed" pipe insulation in damp locations, e.g. pipe trenches shall have a vapour barrier jacket, vapour sealed.

- .3 "Exposed" flexible insulation shall be painted with a heavy brush coating of foam plastic white insulation coating.
- .4 "Exposed" insulation inside the building shall be finished as follows:
- .5 Basic Finish:
 - .1 Apply pipe insulation with an integral all-service type jacket.
 - .2 Cover longitudinal and circumferential joints with jacket finishing tape neatly applied.
 - .1 Alternately secure jacketing longitudinal joint using integral self-sealing lap.
 - .3 Cover circumferential joints with jacket finishing butt strips. Over wrap strips by 50 percent.
 - .4 For insulation O.D. 300 mm [12"] apply strips on 250 mm [10"] centres for additional securement.
 - .5 PVC jacketing is not acceptable a substitute for a vapour barrier. Use ASJ or mastic system under it.
 - .6 Over insulation on short pipe runs and piping adjacent to fittings, valves, etc., jacket to be field applied.
 - .7 Over insulated fittings apply tack coat of vapour barrier mastic and embed reinforcing membrane and cover with same mastic.
 - .8 Over insulated valve bodies, valve bonnets, strainers, and flanges, apply all-service jacketing using necessary fastenings and jacket finishing tape and with the reinforced mastic system on irregular surfaces.
- .6 PVC Jacket Finish:
 - .1 Over a factory applied integral all-service type jacket on the pipe insulation, apply PVC jacket.
 - .2 Over insulated fittings apply PVC fitting covers.
 - .1 Over insulated valve bodies, valve bonnets, strainers and flanges apply purchased PVC covers or field fabricate from PVC sheeting secured with solvent bonding cement.
 - .3 Finish fabric with one (1) coat of fabric coating.
- .7 Canvas Finish:
 - .1 Over a factory applied integral all-service type jacket on the pipe insulation, apply canvas jacket.
 - .2 Over insulated fittings apply PVC fitting covers and canvas jacket.
 - .3 Over insulated valve bodies, valve bonnets, strainers and flanges apply purchased PVC covers or field fabricate from PVC sheeting secured with solvent bonding cement and apply canvas jacket.
 - .4 Finish fabric with one (1) coat of fabric coating.
- .8 Aluminum Finish:
 - .1 Use in areas subject to traffic or mechanical damage, and all insulation outdoors, and were specifically called for on mechanical dwg's or equipment schedules.
- .9 "Exposed" outdoor insulation, including in the parking garage, shall be finished as follows:
 - .1 Insulation shall have a vapour sealed vapour barrier jacket.
 - .2 Over the pipe insulation jacket apply aluminum protective jacket.
 - .1 The longitudinal seam shall be located to shed water.

- .3 Secure the jacket using necessary metal banding on approximately 250 mm (10") centres and at the overlaps.
 - .1 Screws are not permitted on cold operating systems since they will penetrate the vapour barrier.
- .4 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply metal jacket or preformed metal fittings to provide a complete jacket system. Secure with necessary fastenings.
- .5 Seal all outdoor jacketing watertight.

3.9 INSULATION PACKING OF PIPE SLEEVES

- .1 Tightly pack the space between all pipe sleeves and pipe or between pipe sleeve and pipe insulation with mineral wool insulation.
- .2 Apply fire stop compound to prevent transmission of sound and/or passage of fire/smoke.

3.10 CONNECTIONS TO EXISTING PIPING

- .1 Make good all existing insulation disturbed or removed to facilitate alterations and additions to existing piping.

3.11 HEAT TRACED PIPE INSULATION

- .1 Insulation shall completely cover heat tracing.
- .2 Oversize insulation as necessary.
- .3 Provide suitable identification for those pipe systems provided with heat tracing.
 - .1 At intervals of 6 m [20 ft], provide on outside surface of insulation an adhesive backed nameplate "Caution - Heat Tracing."

3.12 SCOPE OF INSULATION WORK

- .1 Insulate the following systems, unless otherwise noted:
 - .1 Domestic cold water system including meter body
 - .2 Domestic hot water supply and recirculation piping.
 - .3 Water valves, flanges, PRV's, strainers, check valves.
 - .4 Traps on handicapped lavatories.
 - .5 Sprinkler / standpipe system from domestic water connection point to 5 metres [16 ft] downstream thereof or to the inlet of the alarm valve, whichever is less.
- .2 DO NOT insulate the following, unless otherwise noted:
 - .1 Piping used exclusively for fire protection (unless in unheated spaces).
 - .2 Soil stacks, vents, etc.,
 - .3 All special service piping, e.g. gas, compressed air, etc.
 - .4 Unions.
 - .5 Flexible connections or expansion joints (unless noted on the drawings).
 - .6 Check valve covers.
 - .7 Strainer leg and basket covers.
 - .8 Flexible fixture connections.

3.13 HOT PIPE INSULATION APPLICATION

- .1 Apply mineral fibre insulation when pipe surface temperatures are 25°C to 120°C.
- .2 Apply insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings.
 - .1 Seal butt joints with 100 mm wide ASJ tape.
- .3 Terminate insulation at each end of valves, unions, and flanges. Cut to a 45° bevel to allow room for tools. Trowel finishing cement into bevel.
- .4 Cover fittings and valves with equivalent thickness of finishing cement.
- .5 Apply finishing cement over exposed fittings and valves before applying canvas recovering.
- .6 Insulate with tightly placed flexible insulation and apply PVC fitting covers.
- .7 Cut insulation layers straight on 10 m centers with 25 mm gap to allow for expansion between terminations.
 - .1 Pack voids tightly with insulation and protect joints with aluminum sleeves.
- .8 Recover exposed insulated piping as indicated.
- .9 Recover insulated piping exposed to outdoors with waterproof aluminum jacket system.
- .10 Do not insulate the following piping system components:
 - .1 Hot water heating piping in radiation cabinets.
 - .2 Unions, flanges, strainers, expansion joints, flexible piping connectors.
 - .3 Condensate trap assemblies and drip legs.
 - .4 Chrome plated.
 - .5 Valve bonnets on domestic water systems.
 - .6 Drains, plugs, and caps.

3.14 COLD PIPE INSULATION APPLICATION

- .1 Insulate 2.5 m [8'] portion of plumbing vents measured from roof outlet back. Do not insulate remaining vent piping.
- .2 Insulate storm sewer piping throughout. Insulate final 2.5 m [8'] portion from outlet drain back with 25 mm [1"] insulation.
- .3 Apply vapor retardant insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings.
- .4 Apply adhesive to ends of butt joints and seal joint seams with 100 mm [4"] wide strips of joint tape.
- .5 Terminate insulation at each end of valves, unions, and flanges. Cut to a 45° bevel to allow room for tools. Trowel finishing cement into bevel.
- .6 Insulate complete system including valves, unions, flanges, strainers, drains, caps, and fittings.
 - .1 Cover fittings and valves with equivalent thickness of finishing cement.
 - .2 Cover finishing cement with open mesh glass cloth and vapor retardant adhesive.
- .7 Seal lap joints with 100% coverage of joint tape and seal the assembly with vapor retardant adhesive.
- .8 Alternatively, insulate with tightly placed flexible insulation and apply reinforcing membrane embedded in vapor retardant coating and apply PVC fitting covers.
- .9 Recover exposed insulated piping as indicated.

- .10 Recover insulated piping exposed to outdoors with aluminum jacketing system.

3.15 INSULATION TYPE AND THICKNESS SCHEDULE

- .1 Evaporator Drip Pan Drains
 - .1 Design Operating Temperature 11°C [51°F] and above
 - .2 Pipe Size / Insulation Thickness: not required
- .2 Evaporator Drip Pan Drains
 - .1 Design Operating Temperature 10°C [50°F] and lower
 - .2 Pipe Size / Insulation Thickness:
 - .1 All Pipe Sizes: 25 [1"]
- .3 Domestic Cold Water
 - .1 Design Operating Temperature less than 4.9°C [41°F]
 - .2 Pipe Size / Insulation Thickness:
 - .1 25mm [1"] and less: 25 [1"]
 - .2 30mm [1-1/4"] and larger: 40 [1.5"]
- .4 Domestic Hot & Tempered Water Supply and Recirculation
 - .1 Design Operating Temperature 50-90°C [120-200°F]
 - .2 Pipe Size / Insulation Thickness:
 - .1 25mm [1"] and less: 40 [1.5"]
 - .2 30mm [1-1/4"] and larger: 50 [2"]
- .5 Buried & Exterior Rainwater Storm Drainage
 - .1 Design Operating Temperature 5°C [40°F]
 - .2 Pipe Size / Insulation Thickness: not required
- .6 Above Grade Interior Rainwater Storm Drainage including drain bodies
 - .1 Design Operating Temperature, 5°C [40°F]
 - .2 Pipe Size / Insulation Thickness:
 - .1 All sizes: 40 [1.5"]

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides Product Requirements to indicate Plumbing Equipment manufacturers that are generally acceptable for bidding on the project.
- .2 The named manufacturers shall comply with all specific requirements of the Project, as well as details and performance as indicated by the Standard of Acceptance named in the individual specification sections and the equipment schedules.
- .3 Where a manufacturer's name below is underlined, that manufacturer is generally used as the Basis of Design.
- .4 Refer to Specification Section 20 05 00 General Mechanical Provisions for details regarding Standard of Acceptance, Addition of Acceptable Manufacturers, and Alternate Materials and Equipment.
- .5 Shop Drawings are required to be submitted for all equipment.
- .6 This section refers to Division 22 only. Each of the other Mechanical Divisions (20, 21, 23, and 25) contain a similar section for equipment that falls under that division.
 - .1 For General Mechanical refer to section 20 99 65
 - .2 For Fire Suppression Systems refer to section 21 99 65
 - .3 For HVAC items refer to section 23 99 65
 - .4 For Instrumentation and Controls items refer to section 25 99 65

Part 2 Products

2.1 ACCESS DOORS – BUILDING SURFACES

- .1 Refer to Specification Section 20 05 33

2.2 ACCESS DOORS – WITH BACK BOX

- .1 Refer to Specification Section 20 05 33

2.3 BACKFLOW PREVENTERS

- .1 Zurn, Ames, Apollo, Febco, Watts
- .2 Refer to Specification Section 22 11 00

2.4 DRAINAGE PRODUCTS - CLEANOUTS, DRAINS, HOSE BIBS, WATER HAMMER ARRESTORS

- .1 Mifab, Jay R.Smith, Watts, Zurn, Wade
- .2 Refer to Specification Section 22 13 00

2.5 DRINKING FOUNTAINS & WATER COOLERS

- .1 Acorn Aqua, Elkay, Haws, Halsey Taylor, Oasis, Sunroc
- .2 Refer to Specification Section 22 40 00

2.6 ELECTRIC MOTORS

- .1 Specification Section 20 05 03

2.7 FAUCETS

- .1 Delta, American Standard, Chicago, Grohe, Kohler
- .2 Refer to Specification Section 22 40 00

2.8 FIRE STOPPING

- .1 Specification Section 20 05 31

2.9 FIXTURES

- .1 Refer to Specification Section 22 40 00
- .2 Acrylic, Composite
 - .1 Fiat, Hytec, Swan, Valley, Williams
- .3 Stainless Steel
 - .1 Acorn, AMI, Bradley, Franke, KIL, Kindred, Steel Queen
- .4 Vitreous China
 - .1 American Standard, Crane, Kohler, TOTO

2.10 FLEXIBLE PIPE CONNECTORS

- .1 Refer to Specification Section 20 20 40

2.11 HANGERS AND SUPPORTS

- .1 Refer to Specification Section 20 05 29

2.12 INSULATION

- .1 Piping & Equipment – Manson, Johns Manville, Certainteed, Owens Corning
- .2 Below Lavatories - Prowrap, Trubro

2.13 PIPE GUIDES AND ANCHORS

- .1 Specification Section 20 05 29
- .2 Grinnell

2.14 PIPE & FITTINGS – DWV

- .1 Refer to Specification Section 22 08 31
- .2 Acid Waste: Polyvinylidene Fluoride PVDF, Flame Retardant - Pegas, IpeX, Watts, Orion
- .3 Cast Iron - Bibby St Croix, Charlotte Pipe, Tyler Pipe
- .4 Copper - Great Lakes Copper Ltd., Wolverine
- .5 PVC - Canplas, IPEX, Royal

2.15 PIPE & FITTINGS – WATER

- .1 Refer to Specification Section 22 11 00
- .2 Copper - Great Lakes Copper Ltd., Wolverine

- .3 Ductile Iron - Canada Pipe, Charlotte Pipe
- .4 PEX above grade – IPEX, Rehau, Vanguard, Wirsbo
- .5 PEX in-slab - Wirsbo only
- .6 High Purity Water - GF Piping Systems, IPEX, Chemtrol, stainless steel welded
- .7 Stainless Steel for Potable Water - Type 304

2.16 PIPE FITTINGS & COUPLINGS - GROOVED END

- .1 Victaulic only
- .2 Refer to Specification Section 22 11 00

2.17 PRESSURE RELIEF VALVES

- .1 Watts, Mifab, Jay R.Smith, Zurn
- .2 Refer to Specification Section 22 11 00

2.18 SEISMIC RESTRAINTS

- .1 Specification Section 20 05 49

2.19 VALVES

- .1 brass, butterfly, cast iron - Crane, Apollo, Jenkins, Kitz, Nibco, Red & White/Toyo
- .2 fixture shut off - Brass Craft, Dahl
- .3 flush valves, urinal & water closet - Delta
- .4 pressure reducing, air - DeVilbiss, Fischer, Watts
- .5 pressure reducing, gas - Fisher, Rockwell
- .6 pressure reducing, water - Watts, Apollo, Clayton, Conbraco, Singer, Wilkins, Zurn
- .7 pressure & temperature relief - Watts
- .8 PVC - Chemtrol
- .9 thermostatic or pressure mixing - Guardian, Bradley, Lawler, Leonard, Powers, Symmons

2.20 VIBRATION ISOLATORS

- .1 Specification Section 20 05 48

Part 3 Execution

3.1 NOT APPLICABLE.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides General, Product, and Execution Requirements for Custom Air Handling Units.
- .2 Provide all required Custom Air Handling Units and accessories as indicated, including, but not limited to:
 - .1 Custom Air Handling Units, Outdoor

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 23 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 23.
- .4 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Plumbing Systems - Division 22
 - .4 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .5 Controls and Instrumentation - Division 25
 - .6 Electrical - Division 26/27

1.3 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 All equipment, materials, installation, and testing shall conform to the following standards as a minimum:
 - .1 Provincial Building Code
 - .2 Local Building By-Laws
 - .3 Provincial Safety Authority

1.4 QUALITY ASSURANCE

- .1 Refer to Section 20 05 00 General Mechanical Provisions, Quality Assurance for additional details.
- .2 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
- .3 Installation shall be done in accordance with well-established practice and standards accepted and recognized by the Consultant and the Trade.
- .4 Unit and major components shall be product of the same manufacturers regularly engaged in production of such units who issues complete catalogue data on such products.
- .5 Units and major components shall be produced by a recognized manufacturer who maintains a local service agency and parts stock.

- .1 Unit and major components shall be product of the same manufacturers regularly engaged in production of such units who issues complete catalogue data on such products.
- .2 Unit shall be factory built and carry all necessary approvals.
- .6 Air handling units and major components shall be products of manufacturing firms regularly engaged in production of such equipment whose products have been in satisfactory use in similar service for not less than 10 years.
- .7 Fans shall conform to AMCA bulletins regarding testing and construction.
 - .1 Airfoil fans shall bear the AMCA certified rating seal for airflow and sound. Fan shall be run and tested to performance.
 - .2 Test results shall be submitted for vibration sound and airflow performance.
- .8 Unit shall be factory built and carry all necessary approvals.
 - .1 Coils shall be water tested and ARI certified.
 - .2 Fans shall be run and tested to performance.
 - .3 Test results shall be submitted for vibration sound and airflow performance.
- .9 Units with factory wiring shall be factory UL/ETL/CSA approved and labeled.
 - .1 Failure to comply with this requirement will necessitate the manufacturer, at his expense, to have a certified UL/ETL/CSA representative inspect the equipment prior to affixing a label.
- .10 Air filter maximum face velocity shall be 2.0 m/s.
- .11 Air filter media shall be ULC listed.
- .12 The following shall be used as selection criteria and shall be as specified: airflow rates, external static pressures, water flow rates.
 - .1 The following are to be equaled or bettered: coil face velocities, filter face velocities, casing leakage rates, casing, and base deflection.
 - .2 The following shall be met within 10% of specified values: water pressure drops.
- .13 Review project schedule and ensure that shop drawing submission and review unit delivery is compatible with project requirements.
 - .1 Allow a minimum of 6 weeks for shop drawing review process.
- .14 Manufacturers shall provide construction methods to achieve sound data as specified and provide data obtained by either:
 - .1 AMCA lab simulation
 - .2 Test data of actual unit
 - .3 All sound data shall be measured and provided in accordance with ARI Standard 260P
- .15 Units shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and the fan has been test-run under observation.

1.5 SUBMITTALS

- .1 Comply with Division 01 and Section 20 05 05 Documentation and Submittals.
- .2 Comply with Section 23 05 00 Common Work for HVAC Systems, Submittals
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to this Specification Section.
- .4 Shop Drawings

- .1 Submit shop drawings in accordance with Division 01 and Section 20 05 05 Documentation and Submittals.
- .2 Shop drawings are required for all materials and equipment.
- .3 Product data shall include dimensions, weights, capacities, certifications, component performance, electrical characteristics, casing construction details, wiring interconnections, gauges, and material finishes.
- .4 The submittal shall provide all technical information relevant to the product being provided, including but not limited to, all the information shown in the schedules of this specification.
 - .1 It is the responsibility of the supplier to highlight any variances his equipment has with the requirements of this specification whether or not pre-approval has been obtained.
 - .2 Information shall be provided in the same measurement units as indicated elsewhere in this specification.
- .5 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules.
- .6 Product data shall include dimensions, weights, capacities, certifications, casing construction details, gauges and finishes of material.
- .7 The submittal shall provide fan curves, not fan tables, with specified operating points clearly plotted.
 - .1 Submit fan curve details, showing operating points at clean filter, dirty filter and mid-point loaded filter with the parameters specified.
 - .2 Select fans at maximum efficiency for specified duty.
- .8 The submittal shall provide coil selection worksheets, clearly showing proper consideration for altitude, air density, glycol corrections and indicate coil tube fin and casing construction.
- .9 The submittal shall provide filter information, including initial APD, final APD, dust spot efficiency, final dust holding capacity, filter media description, filter frame details, and filter removal details.
- .10 The manufacturer shall submit sound power levels for both air handling unit inlet, outlet and radiated at rated capacity.
 - .1 If the unit exceeds sound power levels at scheduled conditions, the manufacturer must provide sound attenuators and meet specified BHP.
 - .2 Submit the AHU sound data for 90% (current demand) and 100% (future demand) airflows.
- .11 Submit sound power levels for air handling unit inlet and outlet and casing radiation at rated capacity in accordance with AMCA.
- .12 The manufacturer shall submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field installed wiring.
- .13 Submit the manufacturers recommended installation instructions.
- .14 Omission of any of the above information will cause shop drawings to be immediately returned without review.
- .15 Shop drawings shall include motor efficiencies for all motors.
 - .1 Refer to Section 20 05 03 Electric Motors for minimum motor efficiencies.
- .16 Submit each air-handling unit on a separate scale drawing showing construction details and dimensions of entire unit and internal components.

- .5 Product Options and Substitutions
 - .1 Refer to Division 01 and Section 20 05 00, for requirements pertaining to product options and substitutions.
- .6 Maintenance Data
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Submit manufacturer's recommended maintenance tasks for a one-year period. Include maintenance schedules and lubrication products.
 - .3 The manufacturer shall include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
 - .4 Submit operating and maintenance data for inclusion into the manuals.
- .7 Occupancy Documentation Requirements
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 The manufacturer shall deliver products to site on a factory-installed base rail or shipping skid and ship units by truck with 10 mil poly shrink-wraps.
- .2 The contractor shall store and protect products.
- .3 The contractor shall store products in a clean dry place, protect them from weather and construction traffic, and shall handle products carefully to avoid damage to components, enclosures, and finish.
 - .1 Units shall be heated and ventilated during storage.

1.7 EXTRA STOCK

- .1 The manufacturer shall provide two sets of filters (one of which shall be a spare set) and one set of spare belts.

Part 2 Products

2.1 GENERAL REQUIREMENTS

- .1 General
 - .1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule. Unit shall be rated for -60°F (-76°C) operation.
 - .2 Substitution of any product other than that specified must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.
 - .3 Unless stated otherwise, air-handling units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close approximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination.
 - .4 All electrical circuits shall undergo a dielectric strength test and shall be factory tested and checked as to proper function.

- .5 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifty (50) continuous years of proven production experience.
- .6 Air Handling Units shall be as manufactured by Engineered Air and be base bid. Cost savings must be shown for alternate products, and it must be clearly indicated in all areas where the alternate products do not meet the specified product.
- .2 Unit Construction
 - .1 Unit casing shall be of minimum 18 ga (1.3 mm) satin coat galvanized sheet metal. Surfaces on indoor and outdoor units shall be cleaned with a degreasing solvent to remove oil and metal oxides. Outdoor units shall be primed with a two-part acid based etching primer. All unprotected metal and welds shall be factory coated.
 - .2 All exposed surfaces shall have a finish coat of alkyd enamel to all exposed surfaces with an ASTM B117 11 salt spray rating of 500 hrs.
 - .3 All walls, roofs, and floors shall be of formed construction with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant.
 - .4 The following components shall be provided with a 22 ga (.85 mm) solid, or 24 ga (.70 mm) perforated (40% free area) satin coat galvanized metal liner over insulated areas:

	Solid liner	Perf. Liner
Fan Section(s)	---	---
Coil Section(s)	---	N/A
Filter Section(s)	---	N/A
Access Section(s)	---	---
Humidifier Section	---	N/A
Underside of Unit	---	---

- .5 Units shall be provided with access doors to the following components: fans, motors, filters, dampers and operators, access plenums, humidifiers/wet cells, electrical control panels and burner/compressor compartments. Access doors shall be as large as practical for easy access. Screwed wall panel access will not be acceptable for the above listed components.
- .6 Units shall be provided with hinged access doors with e-profile gasket, fully lined, and a minimum of two lever handles.
- .7 All units shall be internally insulated with 1" (25 mm) thick, 1 1/2 lb./ft.3 (24 kg/m3) density coated insulation. The coated insulation shall be secured to metal panels with a fire-retardant adhesive and welded steel pins at 18" (450 mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent deterioration of exposed edges. Drain pans and all floor areas shall be insulated on the underside.
- .8 Cooling coil drain pans shall be fabricated of 304 stainless steel and are an integral part of the floor paneling, a minimum of 2" (51 mm) deep with welded corners. Drain

- pans shall extend a minimum of 6" (152 mm) downstream of coil face and be provided with a 1 ½" (38 mm) S.S. M.P.T. drain connection. All cooling coil drain pans shall have a fast pan and be sloped and pitched such that there is no standing water. Intermediate drain pans shall be provided where required for effective moisture removal.
- .9 Outdoor units shall be weatherproofed and equipped for installation outdoors. Units shall be fabricated to prevent the infiltration of rain and snow: louvers or hoods shall be provided on air intakes and exhaust openings. Rain gutters or diverters shall be installed over all access doors. All joints shall be caulked with a water resistant sealant. The roof joints shall be turned up 2" (51 mm) with three break interlocking design and the outer wall panels shall extend a minimum of ¼" (6 mm) below the floor panel.
- .10 Provide full perimeter roof mounting curb of heavy gauge sheet metal at a minimum of 12" (305 mm) high complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25 mm) upturn on inner perimeter to provide a complete seal against the elements. External insulation and flashing of the roof-mounting curb shall be provided by the roofing subcontractor.
- .3 Fans
- .1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.
- .2 Single low pressure forward curved fans of 18" (457 mm) diameter or smaller shall be equipped with greaseable pillow block bearings supported on a rigid structural steel frame.
- .3 Fan motor sheaves shall be adjustable with motors 7 1/2 HP (5.6 kW) and smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
- .4 Provide full section return air fan(s) as scheduled. The use of power exhaust propeller type arrangements will not be considered.
- .5 Fan and motor sheaves shall be factory installed, fan balanced and tested prior to shipment.
- .6 Motor, fan bearings, and drive sheaves assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly where required. Motor mounting shall be adjustable to allow for variations in belt tension.
- .7 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor that is welded to the structural frame of the unit. Use of separate bumpers or snubbers are not acceptable. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric with a sealed double locking fabric to metal connection. The isolators shall be neoprene-in-shear type for single 9" (230 mm) to 15" (380 mm) diameter forward curve fans.
- .8 Provide seismic restraint type neoprene-in-shear type isolators.
- .9 Provide single extended grease line from far side to access side bearing
- .10 Fan motors shall be ODP (open drip proof) high efficiency type.
- .4 Coils

- .1 Coils shall have 3/8" O.D. diameter tubes as manufactured by Engineered Air and constructed of copper tube, aluminum fin, and copper headers.
 - .2 Fins constructed of aluminum or copper shall be corrugated for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All hydronic and DX refrigerant coils shall be factory tested with air at 300 psig (2068 kPa) while immersed in an illuminated water tank. All condenser refrigerant coils shall be factory tested with air at 650 psig (4482 kPa) while immersed in an illuminated water tank.
 - .3 Coils shall be removable from the unit at the header end unless shown otherwise on the drawings.
 - .4 Hydronic and DX refrigerant coils shall be circuited to provide adequate tube velocities to meet design requirements. Internal turbulators are not acceptable.
 - .5 5/8" O.D. tube diameter water coils shall be AHRI Certified.
 - .6 Heat pump refrigerant evaporator/condenser coils shall be equipped with distributors connected to the coil by copper tubes. When a condensing unit is supplied by Engineered Air and a hot gas bypass valve is required, a 5/8" (16 mm) O.D. spigot will be provided at the top of the suction header. Solenoid valves, expansion valves, and related accessories shall be provided and installed by the refrigeration contractor.
 - .7 Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling/heating effect over the entire coil face at reduced load conditions.
- .5 Electric Heat
- .1 Electric resistance heaters shall be provided in the capacities, voltage, and steps of control as noted in the Schedules and shall bear a listing or certification mark from an authorized agency.
 - .2 Heater elements shall be installed a minimum of 12" (305 mm) downstream from air filters.
 - .3 Heater element wiring shall terminate in a full height enclosure at one end of the heater. All internal wiring shall terminate on clearly identified terminal blocks. A wiring diagram shall be provided on the enclosure cover.
 - .4 Heaters shall be equipped with an automatic reset disc type thermal cut-out.
 - .5 Heater elements shall be open type nickel-chromium construction (60% Ni, 15% Cr, 25% Fe). Coil terminal pins shall be mechanically secured and insulated from the frame by means of non-rotating ceramic bushings.
 - .6 Heating coil casings shall be galvanized of suitable gauge as required.
 - .7 Electric Heat Control shall be complete with
 - .1 Silicon Controlled Rectifier (SCR) performing time based sine wave phase control. The SCR shall be controlled by a factory installed proportional integral controller. The control system may be augmented by step and/or ambient controls. The SCR shall be controlled by unit mounted Carel controller as needed to satisfy the desired supply air temperature.
- .6 Filters
- .1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side of the unit as noted on the drawings.
 - .2 The filters shall be designed to slide out of the unit. Side removal filters shall slide into a formed metal track sealing against metal spacers at each end of the track.

- .3 Filters shall be inserted into a frame grid from the upstream side of the filter section. Air filter holding frames shall be satin coated galvanized steel with filter sealing flange, centering dimples, sealing gasket, and lances for appropriate air filter fasteners. Fasteners shall be capable of being installed without the use of tools, nuts, or bolts. A $\frac{3}{4}$ " (19 mm) filter sealing flange shall be an integral component of the holding frame complete with a foam gasket to assure filter to frame sealing integrity. On pre and final filter arrangements, the pre-filters shall fit into the same frame structure and all shall be secured with clips. Filter frame structure shall be reinforced as required to withstand the differential pressure.
- .4 2" (50 mm) Extended Media (Pleated) Disposable Filters: Filters shall be extended surface pleated complete with 100% synthetic media that does not support microbial growth. Frame shall be a high wet strength beverage board with a cross member design that increases filter rigidity and prevent breaching. Frame shall be recyclable. Filters shall have an expanded metal support grid bonded to the air-exiting side of the filter to maintain pleat uniformity and prevent fluttering. Metal support grid shall be recyclable. The filters shall be MERV 8 per ASHRAE 52.2. and rated U.L. 900 Class II. A permanent re-usable metal enclosing frame shall be provided for side loaded applications.
- .5 DAMPERS
- .6 certified low leak tested to AMCA Standard 500-89 by an accredited testing laboratory. These dampers include: rigidly formed satin coat galvanized steel frame with corner reinforcing brackets, heavy duty satin coat galvanized damper blades secured with bolts to continuous $\frac{1}{2}$ " (13 mm) diameter steel drive rods, all weather PVC double seal blade gasket, tempered aluminum alloy blade end seal, complete with epoxy enamel coating. Dampers shall be extruded aluminum, low leak, insulated blade Tamco Series 9000 or equal.
- .7 Air inlet/exhaust damper control shall be complete with a two position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position.
- .8 Mixing dampers shall be parallel blade type.
- .9 Two position inlet dampers shall be parallel blade type.
- .7 Mechanical Heating and Cooling
 - .1 Compressors shall be hermetic scroll type set on resilient neoprene mounts. The compressors shall incorporate an internal or external pressure-limiting device to protect the compressor in the event of overpressure. Compressors shall be provided with a means of overload protection. External crankcase heaters shall be locked out during compressor operation.
 - .2 Air Cooled Condenser
 - .1 Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory pressure tested with air while immersed in an illuminated water tank.
 - .2 Condenser fans shall be direct drive propeller type arranged for vertical draw through airflow. Motors shall be weather resistant type with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted in a venturi for optimum efficiency with minimum noise level.
 - .3 Condenser fans shall be fully housed fan with protective screen and fluted blades for optimum efficiency with minimum noise level.
 - .4 Condenser section to form an integral part of the unit.
 - .3 Packaged Air Source Heat pump

- .1 The entire package including fan controls, head pressure control, and all other miscellaneous controls and accessories shall be pre-wired and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination.
- .2 The equipment shall operate in cooling down to 50°F (10°C) ambient temperature for mixed air and 58°F (14.4°C) ambient temperature for make-up-air applications. The equipment shall operate in heating down to 17°F (-8.3°C). Where applicable, multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with electronic expansion valves, sight glass, liquid line filter-driers, and service ports fitted with Schrader fittings. Equipment shall have condensers designed for 15°F (8°C) liquid sub-cooling. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment. unit shall be designed as an air source heat pump. Each refrigeration circuit shall be equipped with reversing valve, check valves, sight glass and liquid line filter driers, suction line accumulator. Both indoor and outdoor coils shall have thermal expansion valves for refrigeration cycle control between heating mode and cooling mode. Defrost cycle shall prevent indoor or outdoor coils from excessive frost build in either heating or cooling operations.
- .3 Packaged units shall be supplied with R-410A refrigerant.
- .4 Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, supply fan contactors and overload protection, control circuit transformer, cooling relays, ambient compressor lockout, anti short cycle and inter stage timers, and automatic reset low pressure controls. Compressors over 6 tons (21 kW) shall be complete with manual reset high pressure controls. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.
- .5 Provide hot gas bypass on the lead compressor to provide freeze protection in the event of low loads.
- .6 Compressors shall be located on the side of the unit in a service enclosure complete with hinged access doors c/w lever handles for ease of service.
- .7 Compressor enclosure shall include 2" (50 mm), 3 lb./ft³ acoustical coated insulation.
- .8 Make-up air and VAV units to have a minimum of three compressors.
- .9 Provide low ambient heating operation to 17°F (-8.3°C) operation.
- .4 Air source heat pump Heating & Cooling Control
 - .1 The Carel controller shall be complete with proportional and integral control with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature.
 - .1 The controller shall provide 3 stages of mechanical cooling, and 3 stages of mechanical heating. The controller shall give priority to mechanical heating vs electric heating.
 - .2 The controller shall have built-in minimum run time and anti-cycle timers.
 - .3 Mechanical cooling shall be disabled below a fixed low ambient temperature setpoint. Mechanical heating shall be locked out below 17F. At this temperature the electric heating section shall provide the required discharge air temperature.
 - .4 Cooling enable/disable shall be through controller demand.
- .8 Factory Supplied Controls and Wiring

- .1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors, and terminals for the connection of external control devices or relays.
- .2 Electric heat units shall include fan access door switch (to shut heater off when door is opened), auxiliary high limit, airflow switch, and heating contactors.
- .3 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.
- .4 Non-fused disconnect switch in NEMA type 3R weatherproof enclosure shall be provided by others.
- .5 Unit mounted 15A GFI receptacle mounted adjacent to control panel. 120 Volt power supply shall be provided by others.
- .6 Controls shall be housed in a control panel mounted in or on the unit that will meet the standard of the specific installation.
- .7 Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure, this device will shut down the fan and close the outdoor air damper.
- .8 Carel Controller
 - .1 A graphic OLED display module shall provide temperatures and status of the equipment.
 - .2 The controller shall have a 9-button keypad for navigation of screens.
 - .3 The controller shall have a computer connection diagnostics via Ethernet complete with web based interface.
 - .4 Minimum operating ambient temperature shall be -40°F (-40°C).
 - .5 The controller shall provide continuous ambient temperature sensing.
 - .6 Self-check on start-up shall be provided to ensure air proving and all sensors are operating within design tolerances.
 - .7 Blower delay functionality shall be provided to ensure damper(s) are open before blower starts.
 - .8 The controller shall have non-recycling auto by-pass low limit with alarm contacts.
 - .9 Temperature control shall be discharge air c/w 0-10VDC reset.
- .9 HRP (QDT) Heat Pipes
 - .1 Heat Exchanger Design
 - .2 The heat recovery device shall be an air-to-air heat pipe heat exchanger. The basis of design shall be the Engineered Air HRP (QDT) heat pipe.
 - .1 The primary heat exchanger core shall be constructed of 5/8" (16 mm) diameter 0.035" (0.9 mm) thick seamless aluminum tubes permanently expanded into fins.
 - .3 The secondary surface shall be continuous plate aluminum fins of corrugated design to produce maximum heat transfer efficiency and reduce the frost threshold of the unit.
 - .1 Tube Construction
 - .1 Each tube shall be an individually sealed heat pipe filled with a working fluid conforming to the Mechanical Refrigeration Code.
 - .2 Heat pipe tubes shall be wicked. The capillary wick of each heat pipe shall be an integral part of the inner wall of the tube to provide a completely wetted surface for maximum heat pipe capacity with minimum heat transfer resistance.

- .4 Air Stream Partition
 - .1 A partition shall be provided to isolate the exhaust and supply air streams from each other to prevent cross-contamination. The partition shall be a single metal tube sheet divider.
- .5 Tubes shall be expanded into each divider to form a positive seal against air leakage.
- .6 Temperature and Frost Control
 - .1 The CenCon c/w ER-XM module shall be complete with proportional and integral control and discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in the discharge air temperature.
 - .1 The controller shall provide temperature and frost control operation c/w accurate supply air temperature control and summer/winter operation.
 - .2 Energy recovery control function shall be incorporated into the control of the system discharge air setpoint. The controller shall utilize the heat recovery device to its full ability prior to enabling additional heating or cooling devices.
 - .3 Controller shall provide frost prevention.
 - .1 When the exhaust air temperature drops below the frost threshold, the controller setpoint shall be overridden to maintain a specific setpoint in the exhaust airstream. This setpoint is calculated based on the dewpoint of the return air to ensure maximum heat recovery is maintained while not allowing frost to accumulate on the heat recovery device.
 - .4 Enhanced Recovery
 - .1 Maximum heat recovery is obtained by first allowing frost to form on the exhaust side of the coil and using a pressure differential switch to sense when this frost forms. Just prior to the frost forming, maximum heat recovery occurs. When frost is detected, the frost control set point is reset upwards, and the heat pipe is sent to defrost mode. Recovery is still achieved but at a lower level until the heat pipe is clear of frost.
 - .5 Tilt Mechanism
 - .1 The HRP (QDT) heat pipe shall be mounted on a cradle with accompanying linkage, fulcrum, actuator, and controls. Flexible connectors shall be installed to permit the necessary tilting movement of the reclaim coil. The flexible connectors shall be a polyester fiber knit style membrane with a PVC coating.

Part 3 Execution

3.1 UNIT INSTALLATION

- .1 Where Air Handling Units are fabricated and shipped in component sections, the components shall be field assembled using bolted, gasketed companion flanges to make a single airtight unit.
 - .1 Test for leakage and seal as required after reassembly.
- .2 Install units as indicated and to Manufacturers' recommendations.

- .3 Maintain proper clearance around equipment to permit performance of service maintenance, coil removal and repair.
- .4 Make ductwork, piping, and wiring connections to the unit in accordance with the drawings.
- .5 Seismically secure floor/roof mounted AHU's to curbs or housekeeping pads by either bolting or welding to embedded steel plates.
 - .1 Ensure curbs/housekeeping pads are securely attached to structure.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides General, Product, and Execution Requirements for Packaged Indoor Heating/Cooling Units.
- .2 Provide all required Packaged Indoor Heating/Cooling Units and accessories as indicated, including, but not limited to:
 - .1 Air Curtain Units

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 23 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 23.
- .4 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Plumbing Systems - Division 22
 - .4 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .5 Controls and Instrumentation - Division 25
 - .6 Electrical - Division 26/27

1.3 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 All equipment, materials, installation, and testing shall conform to the following standards as a minimum:
 - .1 Provincial Building Code
 - .2 Local Building By-Laws
 - .3 Provincial Safety Authority
 - .4 Air Movement and Control Association International, Inc. (AMCA).
 - .5 AMCA 220-21 – Laboratory Methods of Testing Air Curtains for Aerodynamic Performance Ratings.
 - .6 AMCA 222-16 – Application Manual for Air Curtain Units

1.4 QUALITY ASSURANCE

- .1 Refer to Section 20 05 00 General Mechanical Provisions, Quality Assurance for additional details.
- .2 Employ only Tradespeople holding valid Provincial Trade Qualification Certificates.
- .3 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

- .4 Installation shall be done in accordance with well-established practice and standards accepted and recognized by the Consultant and the Trade.
- .5 Units shall be products of manufacturers who provide local service personnel from factory representative, franchised dealer, or certified maintenance service shop.
- .6 Provide start-up service and report.

1.5 SUBMITTALS

- .1 Comply with Division 01 and Section 20 05 05 Documentation and Submittals.
- .2 Comply with Section 23 05 00 Common Work for HVAC Systems, Submittals
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to this Specification Section.
- .4 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Shop drawings are required for all materials and equipment.
- .5 Product Options and Substitutions
 - .1 Refer to Division 01 and Section 20 05 00, for requirements pertaining to product options and substitutions.
- .6 Record Drawings
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
- .7 Maintenance Data
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Submit manufacturer's recommended maintenance tasks for a one-year period. Include maintenance schedules and lubrication products.
 - .3 Submit operating and maintenance data for inclusion into the manuals.
- .8 Occupancy Documentation Requirements
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.

Part 2 Products

2.1 GENERAL

- .1 Refer to Section 20 05 03 Electric Motors for HVAC and 20 05 04 Variable Speed Drives for additional requirements.
- .2 Each unit consists of a factory assembled casing, centrifugal fans, protective inlet screen, discharge nozzle, motor(s), and access panels for motor and fan assembly. Additional accessories as specified. The air curtain provides a specific L/s (CFM) and a uniform outlet velocity across the entire length of the discharge nozzle area. A remote or unit mounted NEMA 12 control panel will be provided.
- .3 All materials used shall be new, without defects and free of repairs. The quality of the materials used shall be in conformance with the performance requirements as specified herein.
- .4 Air curtain unit shall be ULC listed.

2.2 AIR CURTAIN UNITS

- .1 Standard of Acceptance:
 - .1 Berner
- .2 Refer to equipment schedules on the drawings for performance data and additional information.
- .3 Casing:
 - .1 Housing Materials: Top and bottom access panels shall be Aluminum.
 - .2 Unit Support: Integral to the unit frame or casing. All weight bearing structural support shall be formed 11-gauge stainless steel and galvanized steel. Units shall be furnished in single increments of sufficient structural strength to be supported from the top or back per manufacturer's instructions.
- .4 Air Inlet Grille:
 - .1 Inlet screen shall be perforated type.
- .5 Air Discharge Nozzle:
 - .1 Discharge nozzle shall be high efficiency discharge plenum. Air curtain creates a positive air seal with directional air foil vanes. The vanes shall facilitate a deflection of the air stream by +/- 20 degrees.
- .6 Fans:
 - .1 Wheels and Housings: Dynamically balanced curved double inlet double width galvanized blower wheels with brazed hubs and matched blower housings.
 - .2 Drives: Direct Drive. Belt Drive Not Acceptable
- .7 Motors:
 - .1 Type: Total Enclosed Air Over (TEAO) continuous duty.
- .8 Bearings: Heavy duty type, shielded ball bearings of equal size.
- .9 Minimum Requirements
 - 1. 10-speed direct driven double inlet forward curved fans.
 - 2. Fans balanced and rubber isolated.
 - 3. Aluminum cover housing.
 - 4. Electric heating coil where scheduled.
 - 5. Washable filters.
 - 6. Adjustable vanes integral with the unit or remote mounted in the ceiling.
 - 7. High-off-low fan switch integral with unit suitable for remote mounting.
 - 8. Sound level 3 m [10 ft] in front of the unit in free field shall not exceed 59 dbA on high speed and 54 dbA on low speed.
 - 9. Unit shall be ULC listed and shall bear the AMCA certified ratings seal.
 - 10. Unit mounted controller complete with DDC system interface.
- .10 Control
 - 1. ULC listed, industrial type, pre-wired, with components consisting of motor starter, terminal strip, motor overloads and control transformer with 24 volt fused secondary.
 - 2. Standard control panel to be NEMA 12 enclosure.
 - 3. Automatic door switch: remotely installed in the door area to activate the unit each time the door opens and deactivate the unit each time the door closes.

4. Hand/off/auto switch: acts as an override to the automatic door switch. In Hand position the air curtain is on, in Off position the air curtain is off, and in Auto position the air curtain runs via the automatic door switch. Switch to be panel mounted.
5. Indicator lights
6. Disconnect switch

.11 Mounting Accessories

Provide brackets and other mounting accessories as required to permit installation and proper functioning of air curtain to meet project conditions of use.

Part 3 Execution

1.1 Examination

- 1.1.1 Examine the installation location where each air curtain will be installed to confirm that the installation location is in accordance with the Contract Documents and the Manufacturer's Installation Instructions.

1.2 Installation

- 1.2.1 Install each air curtain in accordance with shop drawing and the Installation Instructions provided by the manufacturer of the air curtain, including panel, door switch, wiring and related components required for complete installation.
- 1.2.2 Securely install air curtains plumb, level, and as close as practical to top of opening and face of wall.
- 1.2.3 Install switches where indicated on Drawings.

1.3 System Start-Up

- 1.3.1 Start-up each air curtain in accordance with the manufacturer's Operations and Maintenance Manual and Installation Instructions.

1.4 Field Quality Control

- 1.4.1 Perform the following field tests and inspections and prepare test reports:
 - 1.4.1.1 After installing air curtains completely, perform visual and mechanical check of individual components.
 - 1.4.1.2 After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation.
 - 1.4.1.3 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- 1.4.2 Repair or replace malfunctioning units and retest as specified above.

1.5 Adjusting

- 1.5.1 Adjust air-directional vanes.
- 1.5.2 Adjust fan speed to prepare installed products to perform properly.

1.6 Cleaning

- 1.6.1 Clean the outside of each air curtain of any dirt, debris, grease, grime or other material.
- 1.6.2 Clean the inside of each air curtain of any dirt, debris, grease, grime or other material as necessary to ensure proper operation.
- 1.6.3 Remove any loose debris that may be of harm to the air curtain operation.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides General, Product, and Execution Requirements for Radiant Heating Equipment and accessories.
- .2 Provide all required Radiant Heating Equipment and accessories as indicated:
 - .1 Radiant Heating Panels, Electric

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 23 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 23.
- .4 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Plumbing Systems - Division 22
 - .4 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .5 Controls and Instrumentation - Division 25
 - .6 Electrical - Division 26/27

1.3 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 All equipment, materials, installation, and testing shall conform to the following standards as a minimum:
 - .1 Provincial Building Code
 - .2 Local Building By-Laws
 - .3 Provincial Safety Authority

1.4 QUALITY ASSURANCE

- .1 Refer to Section 20 05 00 General Mechanical Provisions, Quality Assurance for additional details.
- .2 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
- .3 Installation shall be done in accordance with well-established practice and standards accepted and recognized by the Consultant and the Trade.

1.5 SUBMITTALS

- .1 Comply with Division 01 and Section 20 05 05 Documentation and Submittals.
- .2 Comply with Section 23 05 00 Common Work for HVAC Systems, Submittals
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to this Specification Section.
- .4 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Shop drawings are required for all materials and equipment.
 - .3 Shop drawings shall show the physical dimensions of the radiant ceiling panels, all mounting details and pipe connections.
- .5 Product Options and Substitutions
 - .1 Refer to Division 01 and Section 20 05 00, for requirements pertaining to product options and substitutions.
- .6 Maintenance Data
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Submit manufacturer's recommended maintenance tasks for a one-year period. Include maintenance schedules and lubrication products.
 - .3 Submit operating and maintenance data for inclusion into the manuals.
- .7 Occupancy Documentation Requirements
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.

Part 2 Products

2.1 RADIANT CEILING PANELS - ELECTRIC

- .1 Standard of Acceptance:
 - .1 Qmark CP series
- .2 Heat Output and Dimensions:
 - .1 Refer to equipment schedules on the drawings for performance data and additional information.
- .3 C.S.A. or cUL approved.
- .4 Construction:
 - .1 Panels shall be constructed from 22-gauge (front) and 24-gauge (back) galvanized steel panels with overlapping sides riveted together.
 - .2 Heating element shall be cassette element and shall be enveloped by a dielectric insulation.
 - .3 High temperature fibreglass insulation shall cover heating element.
 - .4 Panels shall have an integral thermal cutoff device.
 - .5 Panels shall have earthquake restraint clips
- .5 Panels shall be suitable for "lay-in" arrangement in inverted tee-bar ceiling.
 - .1 Refer to Architectural specification to determine hard metric or imperial sizing.

Part 3 Execution

3.1 RADIANT CEILING PANEL INSTALLATION

- .1 Panel to be installed in drywall ceilings or in tee-bar ceilings as shown.
- .2 Cooperate with other trades to achieve a neat well-coordinated overall installation.
- .3 The panel manufacturer shall supervise the installation of the panels and shall submit an inspection report after inspecting the completed installation.
- .4 All radiant panels shall be installed by personnel wearing white gloves to avoid soiling the panels.
- .5 Provide all necessary trim to properly install the radiant panels in ceiling areas.
 - .1 Trim or cut the radiant panels to fit in any ceiling openings less than the required size.
 - .2 This trimming shall be done by skilled personnel and in such a way that the trimming is not visible once the panel is installed.
- .6 All radiant panels shall be insulated on the non-active face, refer to Section 23 07 16 HVAC Equipment Insulation.
- .7 All isolating valves and balancing fittings for panels shall be located over adjoining accessible tee bar ceilings only.
- .8 Check that the tee-bar ceiling modules have been installed to correct module sizes.
- .9 The panel manufacturer shall ensure that the panel sizes suit the ceiling modules to allow clearance for the thermal expansion of the lay-in radiant panels.
- .10 Check that each panel rests flat on the supporting tee bars or mounting frame along the full length and the full width.
- .11 The tee-bar members in tee-bar ceilings will be provided by others. The tee-bar members will suit the panel installation.
- .12 The panels shall be located where shown on the architectural reflected ceiling plans.
- .13 All system piping shall be thoroughly cleaned, flushed, drained and refilled before radiant panels are connected into the system.
 - .1 Refer to Section 23 25 00 Water Treatment.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 This section provides guidance and requirements to indicate HVAC Equipment manufacturers that are generally acceptable for bidding on the project.
- .2 The named manufacturers shall comply with all specific requirements of the Project, as well as details and performance as indicated by the Standard of Acceptance named in the individual specification sections and the equipment schedules.
- .3 Where a manufacturer's name below is underlined>, that manufacturer is generally used as the Basis of Design.
- .4 Refer to Specification Section 20 05 00 General Mechanical Provisions for details regarding Standard of Acceptance, Addition of Acceptable Manufacturers, and Alternate Materials and Equipment.
- .5 Shop Drawings are required to be submitted for all equipment.
- .6 This section refers to Division 23 only. Each of the other Mechanical Divisions (20, 21, 22, and 25) contain a similar section for equipment that falls under that division.
 - .1 For General Mechanical refer to section 20 99 65
 - .2 For Fire Suppression Systems refer to section 21 99 65
 - .3 For Plumbing Systems refer to section 22 99 65
 - .4 For Instrumentation and Controls items refer to section 25 99 65

Part 2 Products

2.1 ACCESS DOORS – BUILDING SURFACES

- .1 Refer to Specification Section 20 05 33

2.2 ACCESS PANELS - DUCTS/PLENUMS

- .1 Specification Section 23 33 00
- .2 Nailor, Ventlok

2.3 AIR CURTAIN UNITS

- .1 Berner, Mars, Miniviel, Fantech

2.4 AIR HANDLING UNITS

- .1 Custom - Engineered Air, Haakon, Scott Springfield,

2.5 AIR OUTLETS AND INLETS

- .1 Price, Nailor, Titus

2.6 BACKDRAFT DAMPERS

- .1 Light Duty - Price CBD, Ruskin B02/A1, Nailor

2.7 CONTROL DAMPERS

- .1 Low Leakage Type - Arrow-Foil PBDAF & OBDAF, Honeywell Moduflow D642 & D643, Johnson Proportion/Aire D-1200 & D-1300, Ruskin CD36, Tamco 1000, Nailor 1010
- .2 Not Low Leakage Type - Honeywell, Johnson, Ruskin CD35, Nailor 1012
- .3 Round - Ruskin DCRS-25, Nailor 1090

2.8 DUCT CONNECTORS (FLEXIBLE)

- .1 Duro Dyne "Durolon", Ventfabrics "Ventlon", Dynair Hypalon

2.9 DUCTWORK (SPIRAL)

- .1 United Sheet Metal, B.C. Ventilating, Spiro-Lok

2.10 DUCTWORK (FLEXIBLE)

- .1 Plain - Thermaflex SLP10, Flexmaster FAB4, Wiremold 57
- .2 Insulated Acoustic - Thermaflex MKE, Glassflex ABL-181, Wiremold WK
- .3 Insulated – Thermal - Thermaflex MKC, Micro-Aire JFLX SL, Glassflex D-181, Wiremold WGC
- .4 Sawdust Exhaust - Flexible Tubing Spiratube NC-2R

2.11 EXPANSION JOINTS

- .1 Refer to Division 20

2.12 FANS (COMMERCIAL)

- .1 Inline (Square) – Loren Cook, Greenheck, Twin City

2.13 FAN COIL UNITS

- .1 Commercial - Carrier, Trane, Engineered Air, Mcquay
- .2 Institutional - Pace, Engineered Air, Buffalo, Scott Springfield, Haakon
- .3 Fan Terminal Units - E.H. Price, Tempmaster, Titus
- .4 Filters - AAF, Cambridge, Camfil Farr
- .5 Filters - Fibreglass Free - Viledon, Tridec
- .6 Filter Gauges - Refer to Division 20

2.14 GAS DETECTORS

- .1 C.E.T., QEL, Honeywell

2.15 GAUGES, AIR PRESSURE

- .1 Refer to Division 20

2.16 GROOVED JOINT COUPLINGS & FITTINGS

- .1 Victaulic

2.17 INSULATION (DUCT, PIPE, EQUIPMENT)

- .1 Fibre -

.2 Fibre Free -

2.18 LOUVRES

.1 Price, Airo-lite, Alumavent, Westvent, Ruskin

2.19 PIPE CONNECTORS (FLEXIBLE)

.1 Mason, Victaulic (Flexible Couplings)

2.20 PRESSURE GAUGES

.1 Refer to Division 20

2.21 PRESSURE REDUCING VALVES

.1 Steam - Armstrong, Fisher, Jordon, Leslie, Spirax/Sarco, Spence, Watson McDaniel

2.22 PRESSURE RELIEF VALVES

- .1 Steam - Consolidated, Crosby, Kunkle, Lonergan, Spirax/Sarco
- .2 Water (Bypass) - Braukmann, Fulflo, Lonergan
- .3 Water - Watts

2.23 RADIANT CEILING PANELS

.1 Electric - Qmark, Thermaray

2.24 SEISMIC ISOLATORS

.1 Refer to Specification Section 20 05 49

2.25 THERMOMETERS

.1 Refer to Specification Section 20 05 19

2.26 VALVES

.1 Jenkins, Anvil, Crane, Red-White, Toyo, Kitz, Nibco, Apollo

2.27 VIBRATION ISOLATORS

.1 Refer to Specification Section 20 05 48

Part 3 Execution

3.1 NOT APPLICABLE.

END OF SECTION

TABLE OF CONTENTS

PART 1 GENERAL	2
1.1 Related Work	2
1.2 Scope of Work	2
1.3 Codes, Bylaws, Standards and Approvals	2
1.4 General	2
1.5 Shop Drawings	3
1.6 Operating & Maintenance Manuals	4
1.7 Warranty	5
1.8 Electrical Components, Wiring and Conduit.....	5
1.9 Equipment Supplied for Installation Under Other Sections	7
1.10 Freeze Protection	7
1.11 Alarms - General.....	7
1.12 Identification.....	7
1.13 System Commissioning and Calibration.....	7
1.14 Verification of System Commissioning	8
1.15 Demonstration and Instruction to Owner	9
1.16 Maintenance Service During the Warranty Period	10

Part 1

General

1.1

RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Refer to Section 20 05 06 - Commissioning, Demonstration, and Instruction and 20 05 08 – Equipment Testing and Start-up for additional responsibilities of the BAS contractor
- .3 This section shall review the shop drawings of the fire alarm system as provided by Division 26, with respect to the devices affecting the mechanical control system.

1.2

SCOPE OF WORK

- .1 The new control system while being a completely stand-alone system, shall be an expansion of the existing Arena Building Automation System (Delta).
- .2 The new control system shall be fully integrated with the existing system. An additional operator interface shall be installed in Mechanical Utility 106E and tied into the existing operator's workstation is in Geothermal Mechanical Room 113. The intent is to centralize the facility's building management operation and collect real-time data about energy use for Arena. Areas within controls scope of work include:
 - Electrical Room 120E
 - Electrical Room 134E
 - Universal Washroom 101N
 - Janitors Room 102N
 - Storage/Maintenance 111N
 - Main Entry 103N
 - Hall A 117E
 - Hall A 118E
 - Arena Viewing 119E
 - New Dryland Training 110N
 - Men's Washroom 123N
 - Women's Washroom 124N
 - Mechanical Utility 106E
 - Managers Office 107N
 - Service Counter Storage 108N
 - Service Counter 109N
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 25 Controls and Instrumentation.
- .4 The control will be coordinated and provided by the control's contractor including the generation of new graphics for all control components. Graphics to match existing.

1.3

CODES, BYLAWS, STANDARDS AND APPROVALS

- .1 Where multiple versions of the same code are published, the most recent version shall be applied, unless noted otherwise by building codes and local by-laws.

1.4

GENERAL

- .1 The control system is to be fully microprocessor based.
- .2 The controls system is to be complete with all necessary control components and connections to achieve the specified functions and to permit the H.V.A.C. systems to perform properly in the manner described and as hereinafter specified.

- .3 The controls contractor shall furnish all materials, including all central computer hardware and software, operator input/output peripherals, standalone DDC panels, automation sensors and controls and wiring. The controls contractor shall be responsible for the design, installation, supervision and labour services, calibration, all software programming, and checkout necessary for a complete and fully operational Building Automation System.
- .4 The control system and all controllers and hardware including third party devices shall be BACnet Testing Laboratories (BTL) certified.
- .5 The control system is to be set up and adjusted to achieve optimum operation of the H.V.A.C. system. This includes sequencing, timing and readjustment, as required. Modifications to the sequence of operation using points indicated will not be considered as extra to the Contract. These modifications to continue through the construction period, commissioning period and warranty period as required to achieve optimum operation of the mechanical system.
- .6 All new outputs shall each have an integral HOA toggle switch.
- .7 New controllers shall have a minimum 10% spare points at each location.
- .8 Program a trend log and, where appropriate, totalization for each point.
- .9 This Section is a performance specification clarified in certain sections to establish minimum standard of equipment, installation, or level of control. The specification describes the basic functions required but not all of the installation details or components. This Trade is expected to have sufficient experience to be able to design and estimate the cost of an appropriate control system. Materials and work necessary to achieve a satisfactory result will not be considered extra to the contract.
- .10 The contractor shall review all contract documents and visit the site if possible, prior to the closing date of the tender and site confirm the requirements regarding the routing of interconnecting transmission network, etc..
- .11 When preparing shop drawings, review the proposed sequences, suggest improvements and review these with the Consultant.
- .12 Work with the other parties involved in commissioning, assess how the programming can be modified to improve function, review this with the Consultant and modify the programming as instructed by the Consultant.
- .13 The control system shall be a modular, flexible and fully commissioned Direct Digital Control (DDC) System except that controls not scheduled on the points list may be electric. Items identified in the sequence of operation as being under DDC control but which are not included in the points list shall be included in the DDC system.

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Division 20 and Division 23.
- .2 Shop drawings shall include:
 - .1 Control centre layouts.
 - .2 Manufacturer's descriptive technical literature for all equipment and devices.
 - .3 Interconnection schematics.
 - .4 Wiring and piping diagrams.
 - .5 One-line diagram from sensor and control points to Field Interface device and/or standalone DDC panel including all components and cables.
 - .6 Terminal cabinets, including termination listing.
 - .7 Written description indicating sequence of operation. Shop drawings will be rejected if the written description is not included with the submission. Sequences should reference English descriptors and labels for each point described.

- .8 All input/output points which shall include the following information associated with each point.
 - .1 Sensing element type and location.
 - .2 Details of associated field wiring schematics and schedules.
 - .3 Software and programming details.
- .9 Detailed block diagrams of transmission trunk routing and configuration.
- .10 Valve and damper schedules indicating size, configuration, capacity, and locations. If size varies greater than 10%, obtain approval of the Consultant.
- .11 Copies of all system graphics complete with system specific point labels.

1.6 OPERATING & MAINTENANCE MANUALS

- .1 The maintenance manual data is intended to cover the operation and maintenance of all control systems and equipment installed. Forward three (3) copies of the Controls and Instrumentation section of the operating and maintenance manuals to the Balancing Agency to ensure the binding and format of material are compatible. Ensure sufficient time has been given to the Balancing Agency for the compiling of the complete operating and maintenance manuals by the commissioning deadline. One complete manual shall be furnished prior to the time that system or equipment tests are performed.
- .2 The manuals shall include the name, address and telephone number of the control subcontractor installing the systems and a list of emergency numbers for service personnel. The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject.
- .3 Manuals shall be furnished which provide full and complete coverage of the following subjects:
 - .1 Operational Requirements: This document shall describe, in concise English terms, all the functional and operational requirements for the system and its functions that have been established. It shall not require knowledge of digital processor programming or electronic techniques or control system theory.
 - .2 System Operation: Complete guidance and procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats and procedures; and emergency, alarm, and failure recovery procedures. Provide step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes.
 - .3 Functional Description: Detailed documentation, in language readily understandable to engineering personnel, of the theory of operation and specific functions of the system. Provide full details of data communications, including data types and formats, data processing and disposition data link components and interfaces and operator test or self-test of data link integrity for all system components and computer peripherals during each system function and operating mode. Hardware and software functions, interfaces, and requirements shall be explicitly detailed for all system components in all system functions and operating modes. Any operating procedures currently implemented or planned for implementation in an automatic mode shall be stated and described.
 - .4 Software: Documentation of the theory, design, interface requirements, and functions of all software modules and systems for all digital processors. Include test and verification procedures and detailed descriptions of program requirements and capabilities. Provide all data necessary to permit modification, relocation, or other reprogramming and to permit combination of new and existing software modules to respond to changing system functional requirements without disrupting normal control system operation. Include, as a minimum, for all software modules, fully annotated source code listings, error-

free object code files ready for loading via a peripheral device, and complete program cross reference, plus any calling requirements, data exchange requirements, necessary subroutine lists, data file requirements, and other information necessary to ensure proper loading, integration, interfacing, and program execution. All DDC panel software shall be provided individually for each DDC panel while a single section shall reference all DDC panel common parameters and functions.

- .5 Maintenance: Documentation of all maintenance on all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective units. Include calibration, maintenance, and repair of all sensors and controls, plus diagnosis and repair or replacement of all system hardware.
- .6 Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as Test Procedures. A provision for the measurement or observation results, based on the previously published Test Specification, forms the Test Reports. The procedures record and the results of these exercises shall be conveniently bound and documented together.

.4 Refer to Section 23 05 00 for additional requirements.

1.7 **WARRANTY**

- .1 Refer to General Conditions for additional information.
- .2 The system including all hardware and software components shall be warranted for a period of one year following the date of final acceptance per department. Any manufacturing defects arising during this warranty period shall be corrected without cost to the Owner.
- .3 All applicable software as detailed in this specification shall be updated by the Controls Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the Controls Contractor. All future patches to the software shall be made available to the Owner.
- .4 Repairs required by a total system failure, or the malfunction of any priority portion of the system shall be considered an emergency repair and shall be performed within eight (8) hours of the report of the failure.
- .5 Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.
- .6 Provide written assurance that a local service centre will be maintained with a complete stock of replacement parts, and capable of servicing all troubles in the system.
- .7 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the General Conditions.
- .8 Take note of and provide any extended warranties specified.

1.8 **ELECTRICAL COMPONENTS, WIRING AND CONDUIT**

- .1 By Division 25 Control Systems Contractor:
 - .1 All control system components to make a complete and operable system, except those supplied as part of packaged equipment controls, but including all auto-sequencing devices and electrical interlocks required to accomplish the sequences specified hereafter. Refer to the electrical equipment schedule, the electrical drawings and the electrical specification, which describes the limits of the extent to the work in Division 26 serving mechanical systems. Materials, equipment, connections and power not provided by Division 26 but required for the Control System shall be provided under this section.
 - .2 All control circuit transformers (120/1/60 or 24/1/60 and as designated).

- .3 All control wiring and metallic conduit for mechanical system controls.
- .4 Supply, installation and connection of all electric control items including: damper motors, relays, outside sensors, sub-master control circuits, safety devices, electric thermostats, aquastats, flow switches, wiring to terminal strips, proportional controllers, controllers, etc.
- .5 All wiring and conduit from power distribution system to any control devices needing power (including B.M.S components)
- .6 Be responsible for coordinating with Division 26.
- .7 Electrical work installed under Division 25 shall be to the standards specified under Division 26.
- .2 By Division 26 Electrical:
 - .1 All power wiring and conduit from power distribution system up to and including connection to all motors and starters.
 - .2 All disconnect switches required (unless specified in schedules as being integral with equipment).
 - .3 All motor protection switches, stop-start switches, magnetic starters, contactors and hand-off-automatic selector switches except those supplied as part of packaged equipment.
 - .4 Terminal strips within the motor control centres (MCC) for control connections.
 - .5 Fire alarm signals.
- .3 Note:
 - .1 All magnetic starters for equipment shall have the following features supplied under this Division:
 - .1 Hand-off-automatic selector or on-off selector or start-stop buttons in cover with hand-automatic bridge if applicable.
 - .2 Pilot light,
 - .3 120-volt coils,
 - .4 120-volt control transformer and,
 - .5 Four auxiliary dry contacts for interlocks; two normally open and two normally closed.
 - .2 The Controls Contractor is responsible for reading Division 26 plans and specifications to determine scope of responsibility and standards.
- .4 Wiring:
 - .1 Line voltage power or switched power wiring - #12 gauge copper wire minimum.
 - .2 Line voltage control wiring - #14 gauge copper wire, length not to exceed 50 meters; #12 gauge copper wire, lengths exceeding 50 meters.
 - .3 Low voltage – wire as directed by applicable electrical codes and requirements but minimum #20 gauge.
 - .4 All DDC wiring ran in ceiling spaces must be strapped every 3 feet, and not run through sharp edges or corners, cables should not be ran crisscross but in a straight organized fashion.
 - .5 All DDC wiring to have wire tags at both ends.
- .2 Cable:
 - .1 Data transmission cable shall be minimum 18-gauge twisted pairs (shielding as per manufacturers recommendations).

- .2 All new cabling used for network installation shall be a minimum of CAT6 or as recommended by the equipment manufacturer.

1.9 EQUIPMENT SUPPLIED FOR INSTALLATION UNDER OTHER SECTIONS

- .1 Refer to Section 25 09 13 – Instrumentation and Control Devices for equipment to be supplied under this section but installed under the appropriate trade sections.
- .2 The Controls Subcontractor shall be responsible for arranging, coordinating and supervising the installation of the above devices in a suitable manner and readily accessible location.

1.10 FREEZE PROTECTION

- .1 The Building Automation system shall shut down all supply air handling units containing coils, upon sensing air off the coils at 4°C.
- .2 Restart of the units shall be by the B.M.S. operator from the keyboard.

1.11 ALARMS - GENERAL

- .1 No alarm shall be triggered for a device until the device has been started and is in stable operation. Use software time delays to achieve this effect.
- .2 Generate an alarm on the B.M.S. if any equipment is not in the intended operating condition or if any analog input is not within the intended operating range.

1.12 IDENTIFICATION

- .1 Identify all panels and points with a numbering system consistent throughout the DDC network.
- .2 Identify all controls with symbols relating directly to the control diagram. Use plasticized tags, engraved brass, aluminum, metal-photo, or laminated plastic labels and secure them to, or adjacent to the control devices with key chains.
- .3 Identify all junction box covers with control company label. Paint junction box covers to match conduit colour coding purple
- .4 Identify with colour bands, all conduits at all junction and pull-boxes, at both sides of wall and floors and at not more than 7.5m (25 ft.) intervals along the length. Identification bands to be sprayed on and not less than 100mm (4") wide.
- .5 Use colour coded conductors, white for neutral.
- .6 All manual switches, unless they come with standard nameplates, shall be labelled with engraved plastic laminate nameplates to clearly indicate the service. Wording on nameplates shall be subject to approval by the Consultant.
- .7 Identify all DDC panels and associated devices with symbols relating directly to the control diagram. Provide plastic labels for each input and output point with the following information:
 - .1 Point descriptor.
 - .2 Point type and channel number.
 - .3 Corresponding DDC panel number.
- .8 Mount an input-output legend sheet within each DDC panel. This sheet shall include the name of the points connected to each controller, the end device manufacture, part number, model number and shall describe the I/O range. If an I/O module is remotely located, a separate legend sheet for that module shall be included at both locations.
- .9 All Relays shall be labeled and have wire tags.
- .10 Motor control centre and motor starters shall be provided with labels identifying those motors are under remote control.

1.13 SYSTEM COMMISSIONING AND CALIBRATION

- .1 Program each standalone DDC panel immediately following installation.

- .2 Set up and calibrate all control loops and sensors during the initial start-up of the systems and check, recalibrate and readjust as necessary during the Owner's Demonstration and Instruction period.
- .3 Upon completion of the installation, perform all necessary testing and debugging operations satisfactorily.
- .4 Perform all modifications and alterations as required to correct any deficiencies noted during these tests.
- .5 Check sensor calibration and control system operation during the first heating season and prior to the first cooling season.
- .6 Following each visit submit printed graphs of trend logs one week in duration with hourly samples for all analog inputs connected to each DDC panel.

1.14 VERIFICATION OF SYSTEM COMMISSIONING

- .1 Preliminary Tests
 - .1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.
 - .2 Notify the Consultant in writing at least seven days before testing is to take place stating the following:
 - .1 Location and part of system to be tested.
 - .2 Describe testing procedure and anticipated results.
 - .3 Provide all necessary testing equipment and personnel.
 - .4 Provide portable 2-way radios for communications during demonstrations. Provide three units on the same frequency and of sufficient power and quality as to be useful throughout the building.
 - .5 Perform tests in presence of the Consultant.
 - .6 Demonstrate the proper operation of each component.
 - .7 Correct any deficiencies and re-test in the presence of the Consultant, until designated part of the system performs satisfactorily.
- .2 Final Operational Acceptance Test
 - .1 A final operational test of not less than thirty (30) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total installed and operational Control System to demonstrate that it is functioning properly in accordance with all requirements of this specification.
 - .2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software. If the equipment operates at an average effectiveness level (AEL) of at least 95% during the performance test period of thirty (30) consecutive calendar days, it will be deemed to have met the Acceptable Standard of Performance, and final acceptance of the system shall be made, provided the contractor has satisfied all other requirements of this specification.
 - .3 The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period.
 - .4 In the event the required AEL is not reached during the initial thirty (30) consecutive calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for thirty (30) consecutive calendar days.
 - .5 Downtime shall result whenever the control system is unable to fulfill all required

functions detailed within this specification due to any malfunction of either BMS hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed. Downtime created by non-BMS equipment or activities will not be considered as downtime for the AEL calculation.

1.15 DEMONSTRATION AND INSTRUCTION TO OWNER

- .1 The Controls Contractor shall provide the services of competent instructors who will give full instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified.
- .2 The training shall be oriented toward the system installed rather than being a general (canned) training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach.
- .3 The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum.
- .4 A training manual shall be provided for each trainee which describes in detail the data included in each training program. All equipment and material required for classroom training shall be provided by the Contractor.
- .5 Training Program: The training program shall be accomplished in two phases.
 - .1 First phase: this phase shall be for a period of at five days at a time mutually agreeable between the Contractor and Owner. Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. First phase training shall include the following:
 - .1 General control system architecture.
 - .2 System communications.
 - .3 Operation of computer and peripherals.
 - .4 Elementary preventative maintenance.
 - .5 Report generation.
 - .6 Operator control functions.
 - .7 Colour graphics generation.
 - .2 Second phase: this phase of training shall be conducted four to eight weeks after system acceptance for a period of three days. The training shall include as a minimum, but not be limited to:
 - .1 A review of Phase 1 training.
 - .2 Equipment maintenance - this training shall include:
 - .1 General equipment layout.
 - .2 Trouble shooting of all control system components.
 - .3 Preventative maintenance of all control system components.
 - .4 Sensors and controls maintenance and calibration.
 - .3 Programming - this training shall include:
 - .1 System architecture.
 - .2 Application programs.
 - .3 DDC panel programming.
 - .4 Software access code review.
- .6 Demonstration of the Life Safety System:
 - .1 Perform all tests as required by the authorities having jurisdiction, of the firefighter's pressurization control system.

1.16 MAINTENANCE SERVICE DURING THE WARRANTY PERIOD

- .1 The Contractor shall provide all services, materials, and equipment necessary for the maintenance of the entire Control System, for a period concurrent with the warranty period. Any necessary material required for the maintenance work shall be provided by the Contractor.
- .2 The Controls Contractor shall provide one minor and major inspection per quarter or as required by the manufacturer and two major inspections per year, and all service for the required maintenance.
- .3 Major Inspections: these inspections shall include but not be limited to the following:
 - .1 Work as detailed hereinafter for minor inspections.
 - .2 Clean all peripheral equipment, CPU, interface panels, multiplexing panels and microprocessor interior and exterior surfaces.
 - .3 Provide signal, voltage and system isolation checks of all CPU, interface panels, multiplexing panels and peripherals.
 - .4 Provide mechanical adjustments, new ribbons and necessary maintenance on printers.
 - .5 Check and/or calibrate each field input/output device.
 - .6 Run system software diagnostics as required.
- .4 Minor Inspections: These inspections shall include but not be limited to the following:
 - .1 Provide visual and operational checks to all CPU, peripheral equipment, interface panels, multiplexing panels, and field devices.
 - .2 Change filter and check fan for all CPU's peripheral equipment as required.
 - .3 Provide complete back up of BMS system.
 - .4 Regular service calls: these calls shall be performed during regular working hours, 8:00 a.m. to 4:30 p.m. Monday through Friday excluding legal holidays.
- .5 Emergency Service:
 - .1 The Owner will initiate service calls when there is indication that the control system is not functioning properly.
 - .2 The Contractor shall have qualified control personnel available during the warranty period to provide service to the "critical" control system components whenever required at no additional cost to the Owner.
 - .3 The Contractor shall furnish the Owner with a telephone number where the service mechanic can be reached at all times. The service mechanic shall be on the job ready to service the control system within the next eight (8) hours, after receiving a request for service and the work shall be performed continuously until the control system is back in reliable operating condition.
 - .4 Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.
- .6 Records and Logs: records and logs shall be kept of each maintenance task.
- .7 System Modifications: recommendations for system modification shall be provided in writing to the Consultant. No system modification, including operating parameters and control settings, shall be made without prior approval.
- .8 Software: provide implementation of all software maintenance updates. These shall be accomplished as required and full coordination with control system supervisory personnel shall be maintained.

END OF SECTION

TABLE OF CONTENTS

PART 1 - GENERAL	2
1.1 Documents.....	2
1.2 Section Includes	2
1.3 Reference Standards.....	2
1.4 Definitions	2
1.5 Action And Informational Submittals.....	4
PART 2 - PRODUCTS.....	4
2.1 General	4
2.2 Beacon Type Pilot Lights.....	4
2.3 Binary Temperature Devices	4
2.4 Temperature Sensors	5
2.5 Temperature Transmitters (TTR).....	6
2.6 Pressure Transducers (PTD).....	7
2.7 Differential Pressure Transmitters (DPT)	7
2.8 Static Pressure Sensors	8
2.9 Static Pressure Transmitters	8
2.10 Velocity Pressure Sensors	8
2.11 Velocity Pressure Transmitters (VPT)	8
2.12 Flow Switches.....	8
2.13 Temperature Switches (TSW)	9
2.14 Relays.....	9
2.15 Solid State Relays	9
2.16 Current Transducers.....	10
2.17 Current Sensing Relays.....	10
2.18 Current Switches	10
2.19 Override Timers.....	10
2.20 Panels.....	10
2.21 Transformers	11
2.22 Wiring.....	11
PART 3 - EXECUTION	11
3.1 Installation.....	11
3.2 Temperature Sensors.....	12
3.3 Panels.....	13
3.4 Identification.....	13
3.5 Testing And Commissioning.....	13

Part 1 - General

1.1 DOCUMENTS

- .1 This section, along with the Drawings and Division 20 - General Requirements, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SECTION INCLUDES

- .1 Includes:
 - .1 Control devices integral to the Building Management System: transducers, damper operators, dampers, transmitters, switches, controls, sensors, low voltage current transformers.
 - .2 Related Sections:
 - .1 Section 25 05 00 – Controls Work for Control Systems.
 - .2 Section 25 90 01 – Control Sequences of Operations.
 - .3 Section 26 05 00 - Common Work Results.
 - .4 Section 26 27 26 - Wiring Devices & Plates.

1.3 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI).
 - .1 ANSI C12.7-2014, Requirements for Watthour Meter Sockets.
 - .2 ANSI/IEEE C57.13-2016, Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM B148-18, Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
 - .1 NEMA 250-2020, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Air Movement and Control Association, Inc. (AMCA).
 - .1 AMCA Standard 500-D-18, Laboratory Method of Testing Dampers For Rating.
- .5 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE 2019, Applications Handbook, SI Edition.
- .6 Canadian Standards Association (CSA International).
 - .1 CSA-C22.1-21, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.4 DEFINITIONS

Acronyms used in this section include

- 1) AI - Analog Input
- 2) AO - Analog Output
- 3) B-BC - BACnet Building Controller
- 4) B-AAC –BACnet Advanced Application Controller

- 5) B-ASC –BACnet Application Specific Controller
- 6) B-OWS –BACnet Operator Work Station
- 7) CAD - Computer Aided Design
- 8) CPU - Central Processing Unit
- 9) DI - Digital Input
- 10) DO - Digital Output
- 11) EEPROM –Electronically Readable Memory
- 12) ECU –Equipment control unit
- 13) EISA - Extended Industry Standard Architecture
- 14) Ethernet – BACnet TCP/IP Ethernet
- 15) FID – Field Interface Device
- 16) HVAC - Heating, Ventilation, Air Conditioning
- 17) I/O - Input/Output
- 18) ISA - Industry Standard Architecture
- 19) LAN - Local Area Network
- 20) MS/TP -BACnet Master-Slave/Token-Passing
- 21) NIC – Network Interface Controller (see B-BC)
- 22) OS - Operating System
- 23) OT - Operator Terminal
- 24) OWS - Operator Work Station
- 25) PC - Personal Computer
- 26) PTP – BACnet Point-to-Point protocol
- 27) RAM - Random Access Memory
- 28) ROM - Read Only Memory
- 29) PCU – Generic name for B-BC, B-AAC, and B-ASC

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 20 05 05 – Documentation and Submittals, Section 25 05 00 – Common Work for Control Systems.
- .2 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions for specified equipment and devices.

Part 2 - Products

2.1 GENERAL

- .1 All materials used shall be new, without defects and free of repairs. The quality of the materials used shall be in conformance with the performance requirements as specified herein.
- .2 Control devices of each category to be of same type and manufacturer.
- .3 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof assembly.
- .4 Operating conditions: 0 - 32 degrees C with 10 - 90 % RH (non-condensing) unless otherwise specified.
- .5 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .6 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .7 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .8 Outdoor installations: use weatherproof construction in NEMA 4X enclosures.
- .9 All components will be designed to default to a safe position upon failure and will be installed to ensure reliable operation at any failure situation.
- .10 Provide all control devices of high industry standards for intended operation of BMS. Such devices but not limited to the following: end switches, differential pressure transmitters, flow switches, temperature sensors, pressure sensors, flow measurement devices, space thermostat, etc.
- .11 Devices installed in user occupied space not exceed Noise Criteria (NC) of 25. Noise generated by any device must not be detectable above space ambient conditions.
- .12 Temperature range as indicated in Section 25 90 10 – Control Sequences and Operations.

2.2 BEACON TYPE PILOT LIGHTS

- .1 Housing and Lens material: shatter resistant polycarbonate.
- .2 Flash rate 0.51 m/s.
- .3 Candle Power: 6600 Candelas per second.
- .4 Operating temperature range: -35°C to 65°C.
- .5 120V operating voltage, 0.2A.
- .6 ULC listed.

2.3 BINARY TEMPERATURE DEVICES

- .1 Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
- .2 Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
- .3 Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only.

2.4 TEMPERATURE SENSORS

- .1 General: Temperature sensors shall be resistance temperature device (RTD) or thermistor type to following requirements:
 - .1 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
 - .2 Thermistors shall be 3,000 or 10,000 ohms.
 - .3 Sensing element: hermetically sealed.
 - .4 Stem and tip construction: copper or type 304 stainless steel.
 - .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
 - .6 Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
 - .7 Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross section.
 - .8 Space sensors shall be equipped with setpoint adjustment, override switch, display, and/or communication port.
 - .9 Provide matched temperature sensors for differential temperature measurement.
- .2 Room temperature sensors and display wall modules.
 - .1 Temperature sensing and display wall module.
 - .2 LCD display to show space temperature and temperature setpoint.
 - .3 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
 - .4 Jack connection for plugging in laptop personal computer [contractor supplied palm compatible handheld device] [contractor supplied zone terminal unit] for access to zone bus.
 - .5 Integral thermistor sensing element 10,000 ohm at 24 degrees.
 - .6 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
 - .7 Stability 0.02 degrees C drift per year.
 - .8 Separate mounting base for ease of installation.

- .3 Room temperature sensors.
 - .1 Wall mounting, in slotted type covers having brushed stainless steel finish, with or without protective guard.
 - .2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.
 - .3 Sensor shall have a set-point adjustment and occupancy override.
- .4 Duct temperature sensors:
 - .1 General purpose duct type (DTS): suitable for insertion into ducts at various orientations, insertion length shall be suitable for application. Copper sheathed construction.
 - .2 Averaging duct type (ATS): incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance. Copper sheathed construction.
- .5 Outdoor air temperature sensors:
 - .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.5 TEMPERATURE TRANSMITTERS (TTR)

- .1 Requirements:
 - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
 - .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than [.01 degrees C per volt change.
 - .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
 - .4 Input and output short circuit and open circuit protection.
 - .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
 - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
 - .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.
 - .8 Integral zero and span adjustments.
 - .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/50 degrees C.
 - .10 Long term output drift: not to exceed 0.25 % of full scale/6 months.
 - .11 Transmitter ranges: select narrowest range to suit application from following:
 - .12 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
 - .13 0 to 100 degrees C, plus or minus 0.5 degrees C.
 - .14 0 to 50 degrees C, plus or minus 0.25 degrees C.
 - .15 0 to 25 degrees C, plus or minus 0.1 degrees C.

.16 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.6 PRESSURE TRANSDUCERS (PTD)

.1 Requirements:

- .1 Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
- .2 Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
- .3 Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.
- .4 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application.
- .5 Combined sensor and transmitter measuring pressure.
- .6 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, as applicable.
- .7 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .8 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.
- .9 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.
- .10 Temperature effects: not to exceed plus or minus 1.5 % full scale/50 degrees C.
- .11 Over-pressure input protection to at least twice rated input pressure.
- .12 Output short circuit and open circuit protection.
- .13 Accuracy: plus or minus 1 % of Full Scale.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS (DPT)

.1 Requirements:

- .1 Internal materials: suitable for continuous contact with process material measured including compressed air, water, glycol, steam, as applicable.
- .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10%.
- .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 1 % of full scale output over entire range.
- .5 Integral zero and span adjustment.
- .6 Temperature effects: not to exceed plus or minus 1.5 % full scale/50 degrees C or less.
- .7 Over-pressure input protection to at least twice rated input pressure.
- .8 Output short circuit and open circuit protection.

- .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 STATIC PRESSURE SENSORS

- .1 Requirements:
 - .1 Multipoint element with self-averaging manifold.
 - .2 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).
 - .3 Accuracy: plus or minus 1 % of actual duct static pressure.

2.9 STATIC PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
 - .2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.
 - .3 Accuracy: 1 % of span.
 - .4 Repeatability: within 0.5 % of output.
 - .5 Linearity: within 1.5 % of span.
 - .6 Deadband or hysteresis: 0.1 % of span.
 - .7 External exposed zero and span adjustment.
 - .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.10 VELOCITY PRESSURE SENSORS

- .1 Requirements:
 - .1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.
 - .2 Maximum pressure loss: 37 Pa at 1000 m/s.
 - .3 Accuracy: plus or minus 1 % of actual duct velocity.

2.11 VELOCITY PRESSURE TRANSMITTERS (VPT)

- .1 Requirements:
 - .1 Multi-point static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section
 - .2 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
 - .3 Calibrated span: not to exceed 125 % of duct velocity pressure at maximum flow.
 - .4 Accuracy: 1 % of span.
 - .5 Repeatability: within 0.1 % of output.
 - .6 Linearity: within 0.5 % of span.
 - .7 Deadband or hysteresis: 0.1 % of span.
 - .8 External exposed zero and span adjustment.
 - .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.12 FLOW SWITCHES

- .1 Flow-proving switches shall be either paddle or differential pressure type.
- .2 Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum) and shall have adjustable sensitivity with suitable enclosure unless otherwise specified.
- .3 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), enclosure to suit environment, with scale range and differential suitable for intended application.

2.13 TEMPERATURE SWITCHES (TSW)

- .1 Requirements:
 - .1 Operate automatically. Reset automatically, except as follows:
 - .2 Low temperature detection: manual reset.
 - .3 High temperature detection: manual reset.
 - .4 Adjustable setpoint and differential.
 - .5 Accuracy: plus or minus 1 degrees C.
 - .6 Snap action rating: 24V DC or 120V, 15 amps as required. Switch to be DPST for hardwire and EMCS connections.
 - .7 Type as follows:
 - .8 Room: for wall mounting on standard electrical box with or without protective guard as indicated.
 - .9 Duct, general purpose: insertion length = 460 mm.
 - .10 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
 - .11 Low temperature detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.
 - .12 Strap-on: with helical screw stainless steel clamp.

2.14 RELAYS

- .1 Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
- .2 Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable $\pm 200\%$ (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide enclosure suitable for environment when not installed in local control panel.

2.15 SOLID STATE RELAYS

- .1 General:
 - .1 Relays to be socket or rail mounted.
 - .2 Relays to have LED Indicator
 - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
 - .4 Operating temperature range to be -20 degrees C to 70 degrees C.
 - .5 Relays to be CSA Certified.
 - .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.

- .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
 - .1 Control voltage, 3 to 32 VDC.
 - .2 Drop out voltage, 1.2 VDC.
 - .3 Maximum input current to match AO (Analog Output) board.
- .3 Output:
 - .1 AC or DC Output Model to suit application.

2.16 CURRENT TRANSDUCERS

- .1 Requirements:
- .2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:
 - .1 4-20 mA DC.
 - .2 0-1 volt DC.
 - .3 0-10 volts DC.
 - .4 0-20 volts DC.
- .3 Frequency insensitive from 10 - 80 hz.
- .4 Accuracy to 0.5% full scale.
- .5 Zero and span adjustments. Field adjustable range to suit motor applications.
- .6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.17 CURRENT SENSING RELAYS

- .1 Requirements:
 - .1 Suitable to detect belt loss or motor failure.
 - .2 Trip point adjustment, output status LED.
 - .3 Split core for easy mounting.
 - .4 Induced sensor power.
 - .5 Relay contacts: capable of handling 0.5 amps at 30 VAC/DC. Output to be NO solid state.
 - .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
 - .7 Adjustable latch level.

2.18 CURRENT SWITCHES

- .1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

2.19 OVERRIDE TIMERS

- .1 Override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration as required by application.

2.20 PANELS

- .1 wall mounted or Free-standing enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Consultant without adding additional cabinets.
- .3 Panels to be lockable with same key.

2.21 TRANSFORMERS

- .1 24 volt step down transformer designed to power 24-volt control systems.
- .2 "Overload" protection.
- .3 29°C to 41°C temperature rating.
- .4 Energy limiting, meets NEMA Standard DC20
- .5 Mount within proper enclosure.
- .6 Colour code lead wires for primary connections.

2.22 WIRING

- .1 In accordance with Section 26 27 26 - Wiring Devices.
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
 - .1 Field wiring to digital device: #18AWG.
 - .2 Analog input and output: shielded #18 minimum solid copper.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Electrical:
 - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results.
 - .2 Modify existing starters to provide for BMS as indicated in Section 25 05 00 – Common Work Control Systems.
 - .3 Refer to summaries in Section 25 90 10 – Control Sequences of Operations for controls logic.
 - .4 Terminate wires with screw terminal type connectors suitable for wire size, and

number of terminations.

- .5 Install communication wiring in conduit.
- .6 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
- .7 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
- .8 Maximum conduit fill not to exceed 40%.
- .9 Design drawings do not show conduit layout.
- .10 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Consultant to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

3.2 TEMPERATURE SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by non-corroding shields.
 - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
 - .1 Do not mount in dead air space.
 - .2 Locate within sensor vibration and velocity limits.
 - .3 Securely mount extended surface sensor used to sense average temperature.
 - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
 - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors.
 - .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
 - .2 Wire multiple sensors in series for low temperature protection applications.
 - .3 Wire multiple sensors separately for temperature measurement.
 - .4 Use software averaging algorithm to derive overall average for control purposes.
- .6 All sensors shall be stabilized to such a level as to permit on-the-job installations that will require minimum field adjustments or calibration.
- .7 Sensor assemblies shall be readily accessible and adaptable to each type of application in such a manner as to allow for quick, easy replacement and servicing without special tools or skills.
- .8 Install space instruments at a height of 1.5 m above the finished floor, unless otherwise

indicated.

- .9 Install corridor instruments at a height of 2.1 m above the finished floor.
- .10 Locate instruments in the same vertical centreline as light switches.
- .11 Where instruments are indicated on an outside wall install on a stand-off wall bracket which provides an air space between the instrument and the wall; or on an insulating Base (e.g. a cork pad).
- .12 Install protective metal guards on instruments in areas where they may be subject to damage (loading areas, workshops, public corridors and storage areas). Bolt guards, independent of instruments to separate baseplates. Provide backing in wall for securing mounting Bases.
- .13 Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only, and shall not be located in dead air spaces. The location shall be within the vibration and velocity limits of the sensor. Where an extended surface element is required to properly sense the average temperature it shall be securely mounted within the duct to measure the best average temperatures. Elements shall be thermally isolated from brackets and supports to respond to air temperature only. Sensor element to be supported separately and not connected to coils or filter racks.
- .14 Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well. Well shall not restrict flow area to less than 70 percent of line-size-pipe normal flow area.

3.3 PANELS

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .3 Identify wiring and conduit clearly.

3.4 IDENTIFICATION

- .1 Identify field devices in accordance with Section 25 05 53 – Mechanical Systems Identification.

3.5 TESTING AND COMMISSIONING

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 20 05 12 – Coordination with The Balancing Agency.
- .2 All field devices shall be properly calibrated and tested for performance and accuracy.

END OF SECTION

TABLE OF CONTENTS

PART 1 GENERAL 2

PART 2 PRODUCTS 2

Refer to Section 25 05 00 and 25 09 13 2

PART 3 EXECUTION 2

HVAC CONTROL OBJECTIVES 2

ALARMS AND SAFETIES 5

SEQUENCE OF OPERATION 6

Part 1 General

1.1 SYSTEM DESCRIPTION

.1 Fort Saint James Arena consists of the following infill and renovation components:

The mechanical systems for the renovation generally consist of the following:

- .1 A new air handling unit (AHU-1), located outside on the west side of the building. AHU-1 provides ventilation with tempered air to the space via the building BMS system based on adjustable occupancy schedule.
 - .1 Refer to 23 73 11 for the heat recovery ventilator unit (AHU-1) components.
 - .2 The AHU-1 is an electric appliance with a heat pump.
 - .3 The AHU-1 is equipped controller with BACNET interface
- .2 Duct heaters are used to provide heating to areas: main entry, halls, arena viewing, new dryland training, manager office, and service counter as shown on drawings. Duct heaters are controlled by BMS based on heating demand.
- .3 Areas that are not served by AHU-1 have electric baseboard heaters to provide heating. Electric baseboard heaters are controlled by BMS based on heating demand.
- .4 The men's and women's washroom are provided heat by ceiling mounted electric radiant panel heaters. These are controlled by BMS based on heating demand.
- .5 The janitor and the storage/maintenance rooms are exhausted by dedicated ceiling hung exhaust fans. These are controlled by BMS based on adjustable occupancy schedule.
- .6 Air curtains (EAC-X) serving the main entry doors to building are interlocked with the door switch. When the doors are opened air curtains will turn on. Air curtains are controlled and monitored by BMS.
- .7 Refer to Section 25 09 13 for scope of work involving integration of new mechanical equipment controls into existing BMS system

Part 2 Products

REFER TO SECTION 25 05 00 AND 25 09 13

Part 3 Execution

HVAC CONTROL OBJECTIVES

- .1 Program the system to meet the following objectives:
- .2 Temperature: Control the temperature in each occupied space to meet temperature setpoint under all operating conditions.
- .3 Ventilation: Control the system's minimum outdoor air intake and the supply to the room to meet code ventilation requirements under all operating conditions. Control the systems minimum exhaust to applicable rooms to meet code ventilation requirements under all operating conditions
- .4 Energy:
 - .1 Provide no more heating than is essential (no reheat).
 - .2 Provide no more cooling than is essential (no reheat).

- .3 Shut systems down if the building is unoccupied unless the temperature falls below the night setback temperature.
 - .4 Utilize outdoor air for free cooling whenever possible, to maintain the space temperature setpoint.
 - .5 Incorporate setback temperatures during unoccupied periods.
 - .6 Operate equipment at high efficiency under all load conditions.
 - .7 Incorporate heat recovery devices on building exhaust and process exhaust in accordance with code to pre-heat outdoor air.
 - .8 Control the supply air temperature downstream of heat transfer devices to meet space temperature setpoint at lowest energy consumption.
- .5 General
- .1 Set points shall be adjustable on the BMS OWS. All default set-points shall be tested, set and recorded during testing and balancing. Work with testing and balancing agency to assist setting up and verifying default set-points.
 - .2 Final sequence of control shall be optimized by Consultant, Commissioning Agent and Controls Contractor.
 - .3 Ventilation:
 - .1 Control the system's outdoor air intake and the supply to each space to achieve the specified air volumes under all operating conditions.
 - .2 System shall be able to reduce the airflow in all areas to minimum levels, in accordance with ASHRAE 62.1 in unoccupied mode.
 - .4 Energy conservation:
 - .1 Provide no more heating than is essential and as a minimum incorporate the followings for energy conservation while meeting indoor design parameters.
 - .2 Utilize outdoor air for free cooling whenever possible, to maintain the space temperature setpoint.
 - .3 Incorporate heat recovery devices on building exhaust in accordance with code to pre-heat outdoor air.
 - .4 Control the supply air temperature downstream of heat transfer devices to meet space temperature setpoint at lowest energy consumption.
 - .5 Operate equipment at high efficiency under all load conditions.
 - .5 Demand Limiting:

Incorporate controls on heat recovery devices to prevent frosting on heat transfer coil or surface.
 - .6 Occupied rooms shall be provided with a means to:
 - 1. Adjust the room temperature setpoint without affecting adjacent rooms.
 - 2. Activate the HVAC system if in an unoccupied mode.
 - .7 Room and Space Monitoring:
 - 1. Occupied rooms and spaces shall be monitored for temperature.
 - .8 Equipment Monitoring

- .9 Unit Control Panel provided by AHU manufacturer under Div 23 shall include Hand-Off-Auto (H-O-A) switch to accommodate testing as well standalone control of all heating, cooling, and economizer functions. Controller to respond to BMS inputs and permit remote control as per Sequence of operation specified. Manual mode shall not bypass safeties.
- .10 Equipment which does not provide points for monitoring shall be carefully reviewed for the following aspects:
 - .11 Consultation with specified equipment manufacturers for recent improvements and upgrades.
 - .12 Alternative equipment manufacturers that do provide the necessary function.
 - .13 Provision of auxiliary field wired devices such as pressure switches, current sensors, thermocouples, etc.
 - .14 Provision of a network thermostat which can provide a basic level of information such as on/off, heat/cool, space temperature, setpoint.
 - .15 Provision of a smart motor control which can provide a basic level of information such as on/off, motor load, overload.
 - .16 Equipment provided with field-wired devices shall have a supplementary wiring schematic which clearly identifies the location and purpose of each device and the additional wiring provided. The devices and wiring shall be clearly labelled and referenced to the supplementary schematic.
- .17 Equipment Interlocks and Shutdowns
 - .1 Where equipment is required to be shut down due to Code or other safety-related reasons, the equipment shut down shall be accomplished utilizing the equipment shut down contact(s) via a hard-wired connection to the interlocking device or system.
 - .2 Duct smoke detectors shall be provided on HVAC equipment serving fire compartment.
 - .3 Incorporate high temperature protection and alarm on air handling units when return air temperature exceeds 50 deg. C (adjustable).
 - .4 Ventilation air flow shall be proved utilizing a positive failsafe method. The standard of acceptance shall be a differential pressure air flow switch with an upstream pitot tube facing into the air stream and a downstream pitot tube facing away from the air stream.
 - .5 Ventilation air flow proving switches shall be hard-wired to the equipment being interlocked.
- .18 Fans:
 - .1 Incorporate controls on fans to prevent air handling component failure due to the development of excessive pressure conditions during the operation of the system. This shall include consideration for the failure of controls for dampers etc.
 - .2 Incorporate synchronization controls to enable start-up and speed control of supply and interlocked exhaust fans without losing on space pressurization goal.
 - .3 Incorporate controls to modulate speed of exhaust fan(s) within AHU to maintain space pressure set point under variable operating conditions from purge exhaust and/or engine/welding exhaust in bays.

- .4 Monitor source capture exhaust fans and other local exhaust fans and modulate the speed for general exhaust fan(s) and /or operate relief damper(s) so as to maintain space static pressure set point.
- .19 Control dampers:
 - .1 Provide end switches on control dampers to provide positive feedback to BMS on the position of dampers where malfunction of dampers could result in damage to system component or property.
 - .2 Incorporate sequences to operate control dampers on air handling units and exhaust fans to meet the following performance objectives:
 - .3 Outside air and exhaust or relief/exhaust dampers shall remain closed when fan system is not running.
 - .4 Respective fans to run only when related control damper(s) are open as sensed by end switches.
 - .5 Modulate control dampers where required to meet design air flows under variable operating conditions.
 - .6 Operate outside air and exhaust air control dampers to operate packaged air conditioning units in economizer or free cooling mode when outside ambient air temperature or humidity is lower than return temperature or humidity.
 - .7 Operate control dampers on ducts, intake and/or exhaust louvers to meet the space temperature setpoint.
 - .8 Ensure that control sequences do not result in unsafe operation of fan system or freezing condition with equipment or energy loss.
- .20 Manual operation:
 - .1 Incorporate stations for local activation of HVAC system as called for in the Contract Document.
- .21 BMS will monitor the outdoor temperature use their values appropriately in control programs that it performs.
- .22 Freeze and frost protection:
 - .1 Incorporate controls and alarms to prevent freezing conditions within air handling units.
 - .2 Incorporate controls and alarms to prevent freezing conditions within the Facility.
 - .3 Incorporate controls on heat recovery devices to prevent frosting on heat transfer coil or surface.
 - .4 Incorporate controls and alarms to prevent freezing conditions of drip pans of air handling units.

ALARMS AND SAFETIES

- .1 The room temperature sensors shall alarm their high or low alarm condition, as defined in the system database, at the operators Terminal Display Unit (TDU). Alarm points will be taken from dry contacts on the TDU and connected to the existing BMS.
- .2 An alarm shall be generated at the BMS when any motor status as sensed by a current sensing relay does not match the commanded value for that motor.

SEQUENCE OF OPERATION

3.3.1 Environmental Control Setpoints

- .1 Occupied mode temperature setpoint during heating mode (Winter): 20 deg. C (adjustable).
- .2 Unoccupied mode temperature setpoint during heating mode (Winter): 13 deg. C (adjustable).
- .3 Heating mode (Winter) activation: OAT below space temperature setpoint by 1 deg. C (adjustable) .
- .4 Occupied mode temperature setpoint during cooling mode (Summer): 25 deg. C (adjustable).
- .5 Unoccupied mode temperature setpoint during cooling mode (Summer): 28 deg. C (adjustable).

3.3.2 Equipment Operation

3.3.2.1 Air Handling Unit AHU-1

1. Air Handling Unit AHU-1 for Foyer area comprised of the following components:
 - .1 Outdoor air damper
 - .2 Return air damper
 - .3 Frost control face and bypass dampers
 - .4 Filter
 - .5 Supply fan section
 - .6 Return fan section
 - .7 Electric heating coil
 - .8 Heat recovery heat pipe between return air and outdoor air streams
 - .9 Heat Pump
2. Ventilation System Stopped:
 - .1 Supply fan stopped.
 - .2 Outdoor air damper closed.
 - .3 Return air damper open.
 - .4 Return fan stopped.
3. Unoccupied Mode:
 - .1 All equipment deactivated. Start system in 100% return air mode only if required to maintain minimum low setback temperature of 10°C(adjustable).
- .4 System Operation:
 - a. AHU-1 shall be activated by BMS based on occupancy schedule or by manual override.
 - b. Once AHU-1 is enable, AHU's controller shall open the O/A damper position as set during commissioning for design O/A flow rate during normal operation.

- c. Mechanical contractor shall coordinate between the AHU supplier and the existing BMS contractor to ensure seamless integration of both systems. Any revision required to the scope division shall be submitted for review and approval.
 - d. BMS shall generate a supply air temperature set-point. This set-point shall be automatically reset in order to maintain the space temperature set-point.
 - e. On system start, open return air damper to 100% and outdoor air damper to minimum position.
 - f. When proved open, start supply fan (ramp fan up to speed).
 - g. Supply air temperature control:
 - BMS shall generate a supply air temperature setpoint. This setpoint shall be automatically reset in order to maintain space temperature setpoint.
 - BMS to enable heating based on outdoor air temperature.
 - h. Unit shall alarm if any of the following conditions are met:
 - Condensate drain pan heat trace malfunction
- .5 Heating mode:
- .1 BMS shall reset supply air temperature setpoint 22° C in Winter (adjustable).
 - .2 BMS shall control unit heat recovery heat pipe, to preheat outdoor air as required in heating mode.
 - .3 On a call for heating, BMS shall send a signal to AHU-1 control panel to initiate a heat pump to provide heating. When a heating capacity can't meet heating demand, the electric coil kicks in to maintain supply air temperature set point.
 - .4 Internal frost control: Unit measures the exhaust air temperature leaving the unit and modulates the face and bypass damper in order to maintain it above freezing.
- .6 Cooling mode:
- .1 No mechanical Cooling
- .8 Fire alarm shutdown: Fire alarm shall cause air handling unit to shut down.

3.3.2.5 Electric Duct Heater EDH-1 to EDH-6

- .1 BMS to control heater remote temperature sensor to maintain room setpoint of 22°C in Winter. During fire alarm unit to shut down.
- .2 Supply air temperature control: BMS shall generate a supply air temperature setpoint. This setpoint shall be automatically reset in order to maintain space temperature setpoint.
- .3 EDHs shall stop on high temperature and provide alarm at BMS.
- .4 EDHs shall stop when no airflow upstream of EDHs.

3.3.2.6 Electric Radiant Panel ERP-1 to ERP-4

- a. Wall-mounted thermostat shall cycle unit blower and operate electric heating elements to maintain space temperature. Setpoint to be 22°C in Winter unless indicated otherwise. During fire alarm unit to shut down.
- b. Unoccupied Mode:
 - .1 ERP-X unit off. Start unit only if required to maintain a minimum low setback temperature of 10°C (adjustable).
- c. Occupied Mode:
 - .2 Unit shall provide heating to maintain a room temperature of 22°C (adjustable).

3.3.2.7 Exhaust Fan EF-1 to EF-2

- a. DDC shall turn on fan motor when system schedule is set to occupancy mode. Fan motor shall keep running until schedule changes to unoccupied mode. During fire alarm unit to shut down.
- b. Unoccupied Mode:
 - .1 EF-1 unit off.
 - .2 EF-2 unit off.
- c. Occupied Mode:
 - .1 EF-1 shall run exhausting air from space.
 - .2 EF-2 shall run exhausting air from space

3.3.2.8 Electric Air Curtain EAC-1 to EAC-4

- 1) Air curtain to operate whenever entrance door is opened as sensed by door contact switch.
- 2) Air Curtain operation shall be disabled when outdoor temperatures are above 15 deg. C (Adjustable).
- 3) Interlock Control Links:
 - .1 With entrance door switch.
 - .2 With outside air temperature.
- 4) When door opens, air curtain is activated and shall keep running for a minimum run time of 5 minutes or until door remains closed for 5 minutes. This is timer delay is to be controllable by BMS.
- 5) Air curtain supply air temperature and status shall be monitored by BMS. Emergency stop shall be engaged runtime exceeds 20 minutes. This timer is to be controllable by BMS.
- 6) During fire alarm air curtain to shut down.
- 7) Entrance doors open/close status is to be monitored by BMS via door switch.

3.3.2.9 Electrical Rooms: BMS shall monitor room temperature via a temperature sensor.

- 3.3.2.10 Electric baseboard heaters shall operate electric heating elements to maintain space temperature set point. Electric baseboard heaters are to be controlled by BMS. Electric baseboard heater is to maintain the space temperature setpoints to be 22°C for the following spaces:
- Universal Washroom 101N
 - Janitors Room 102N
 - Storage/Maintenance 111N
 - Storage Counter Storage 108N

Electric baseboard heater temperature is to maintain setpoints to be 10°C for
Electrical Room 120E and Electrical Room 134E.

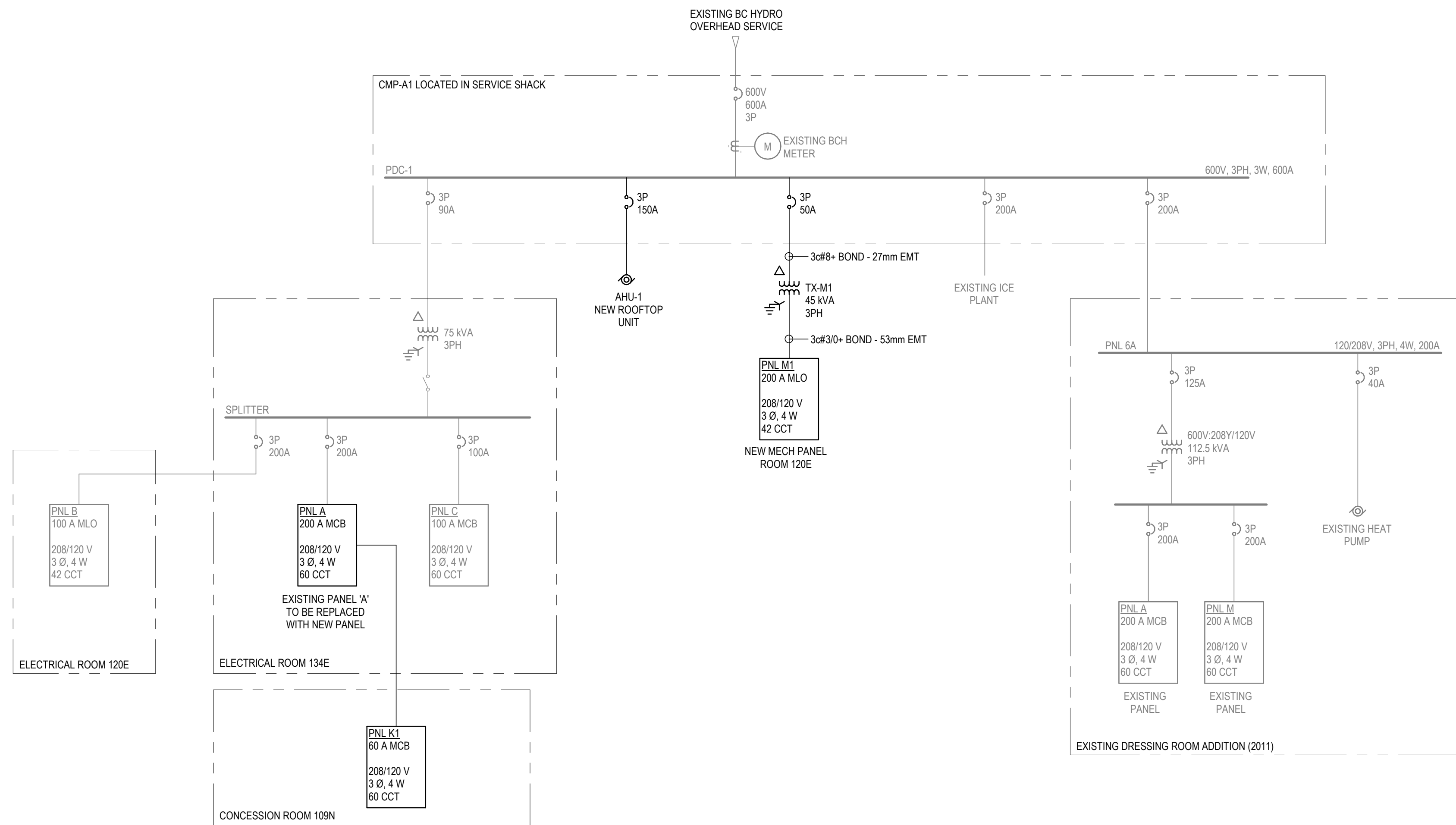
END OF SECTION

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Consultant

Notes



1 SINGLE LINE DIAGRAM
N.T.S.

LUMINAIRE SCHEDULE

LR1		2x4' RECESSED PANEL LIGHT MOUNTING: RECESSED WATTAGE: 40 W LUMENS: 4620 COLOR TEMP: 4000 K CRI: 90 FINISH: WHITE DISTRIBUTION: DIRECT/EDGE LIT DRIVER: 0-10V DIMMING VOLTAGE: 120 V LISTINGS: IC, DAMP LOC. MANUFACTURER: LITELINE CATALOG #: LEDPH-24-WH-D-40-2
LD1		4" RECESSED DOWNLIGHT MOUNTING: RECESSED WATTAGE: 16 W LUMENS: 1450 COLOR TEMP: 3200 K CRI: 90 FINISH: WHITE TRIM DISTRIBUTION: WIDE (90) DRIVER: 0-10V DIMMING VOLTAGE: 120 V LISTINGS: DAMP LOC. MANUFACTURER: PORTFOLIO CATALOG #: LDSQ4B-20-D5L-T-EU4B-1020-90-40-4LB-SQ-0-MW
LS1		4' STRIP LIGHT MOUNTING: SURFACE-CEILING WATTAGE: 75 W LUMENS: 4511 COLOR TEMP: 4000 K CRI: 90 FINISH: WHITE DISTRIBUTION: WIDE DRIVER: 0-10V DIMMING VOLTAGE: 120 V LISTINGS: MANUFACTURER: METALUX CATALOG #: 4SNLED-LD5-44SL-LW-UNV-L840-SLT-D-U
LS2		3.15m/10.3' LINEAR CABINET LIGHT MOUNTING: SURFACE-CHANNEL WATTAGE: 60 W LUMENS: 6695 COLOR TEMP: 3500 K CRI: 90 FINISH: CLEAR DISTRIBUTION: 20° x 30° DRIVER: KELVIX ULV96 VOLTAGE: 120 V LISTINGS: MANUFACTURER: KELVIX CATALOG #: FX-35K-650-2030-SL-12FT-3IN C/W FX-CM-CH CHANNEL
LS3		2.25m/7.4' LINEAR CABINET LIGHT MOUNTING: SURFACE-CEILING WATTAGE: 44 W LUMENS: 3802 COLOR TEMP: 3500 K CRI: 90 FINISH: CLEAR DISTRIBUTION: 20° x 30° DRIVER: KELVIX ULV96 VOLTAGE: 120 V LISTINGS: MANUFACTURER: KELVIX CATALOG #: FX-35K-650-2030-SL-7FT-5IN C/W FX-CM-CH CHANNEL
LW2		WALL MOUNTED VANITY LIGHT MOUNTING: WALL WATTAGE: 8 W LUMENS: 1000 COLOR TEMP: 4000 K CRI: 90 FINISH: WHITE DISTRIBUTION: DRIVER: VOLTAGE: 120 V LISTINGS: MANUFACTURER: AXIS LIGHTING CATALOG #: MBWLED-500-80-840-S-2-AP-120-DALI-1
EL1		SURFACE MOUNTED SOFFIT LIGHT MOUNTING: WATTAGE: 25 W LUMENS: 2283 COLOR TEMP: 3200 K CRI: 90 FINISH: DISTRIBUTION: DRIVER: VOLTAGE: 120 V LISTINGS: MANUFACTURER: COOPER LIGHTING CATALOG #: H12F-LD4-20W-35-CLR-WH-120-EDD1-OS

MECHANICAL EQUIPMENT SCHEDULE

TAG	DESCRIPTION	LOCATION	VOLT	PH	HP	KW	FLA	MCA	MOP	BREAKER	FEEDER SIZE	CONDUIT SIZE	DISCONNECT SW.			STARTER			CONTROL			Comments	
													SUPPLIED	INSTALLED	WIRED	TYPE	SUPPLIED	INSTALLED	WIRED	TYPE	SUPPLIED		INSTALLED
AHU-1	AIR HANDLER UNIT	OUTSIDE	600 V	3							3x1/0 + BOND	53mm	E	E	E								
BB-1	BASEBOARD HEATER	101N UNIV WASHROOM	120 V	1		1.00	8.3			15A	2c#12+ BOND	21mm	E	E	E					M	M	E	OUELLET RBH1008
BB-1	BASEBOARD HEATER	134E ELEC ROOM	120 V	1		0.50	4.2			15A	2c#12+ BOND	21mm	E	E	E					M	M	E	OUELLET RBH1008
BB-1	BASEBOARD HEATER	120E ELEC ROOM	120 V	1		0.75	6.3			15A	2c#12+ BOND	21mm	E	E	E					M	M	E	OUELLET RBH1008
BB-1	BASEBOARD HEATER	108N CONCESSION STORAGE	120 V	1		0.50	4.2			15A	2c#12+ BOND	21mm	E	E	E					M	M	E	OUELLET RBH1008
BB-1	BASEBOARD HEATER	111N STORAGE/MAINTENANCE	120 V	1		0.50	4.2			15A	2c#12+ BOND	21mm	E	E	E					M	M	E	OUELLET RBH1008
BB-1	BASEBOARD HEATER	111N STORAGE/MAINTENANCE	120 V	1		0.50	4.2			15A	2c#12+ BOND	21mm	E	E	E					M	M	E	OUELLET RBH1008
BB-1	BASEBOARD HEATER	102N JANITOR ROOM	120 V	1		0.75	6.3			15A	2c#12+ BOND	21mm	E	E	E					M	M	E	OUELLET RBH1008
EAC-1	AIR CURTAIN	103 MAIN ENTRY	208 V	3		8.00	22.2			35A	3c#8 + BOND	27mm	E	E	E					T	M	E	E
EAC-2	AIR CURTAIN	103 MAIN ENTRY	208 V	3		8.00	22.2			35A	3c#8 + BOND	27mm	E	E	E					T	M	E	E
EAC-3	AIR CURTAIN	103 MAIN ENTRY	208 V	3		8.00	22.2			35A	3c#8 + BOND	27mm	E	E	E					T	M	E	E
EAC-4	AIR CURTAIN	103 MAIN ENTRY	208 V	3		8.00	22.2			35A	3c#8 + BOND	27mm	E	E	E					T	M	E	E
EDH-1	DUCT HEATER	103N MAIN ENTRY	208 V	2		5.99	28.6			50A	2c#6 + BOND	27mm	E	E	E					T	M	E	E
EDH-2	DUCT HEATER	109E ARENA VIEWING	208 V	2		2.50	12.0			20A	2c#12 + BOND	27mm	E	E	E					T	M	E	E
EDH-3	DUCT HEATER	109N CONCESSION ROOM	208 V	2		1.50	7.2			15A	2c#12+ BOND	21mm	E	E	E					T	M	E	E
EDH-4	DUCT HEATER	107N MANAGER'S OFFICE	208 V	2		1.25	6.0			15A	2c#12+ BOND	21mm	E	E	E					T	M	E	E
EDH-5	DUCT HEATER	110N DRYLAND TRAINING	208 V	2		2.50	12.0			20A	2c#12+ BOND	21mm	E	E	E					T	M	E	E
EDH-6	DUCT HEATER	109E ARENA VIEWING	208 V	2		2.50	12.0			20A	2c#10+ BOND	21mm	E	E	E					T	M	E	E
EF-1	EXHAUST FAN	102N JANITOR ROOM	120 V	1	0.25	0.03	0.3			15A	2c#12+ BOND	21mm	E	E	E				WS	E	E	E	
EF-2	EXHAUST FAN	111N STORAGE/MAINTENANCE	120 V	1	0.25	0.03	0.3			15A	2c#12+ BOND	21mm	E	E	E				WS	E	E	E	
ERP-1	CEILING RADIANT PANEL	123N MEN'S WR	208 V	2		0.53	2.6			15A	2c#12+ BOND	21mm	E	E	E					T	M	E	E
ERP-1	CEILING RADIANT PANEL	124N WOMEN'S WASHROOM	208 V	2		0.53	2.6			15A	2c#12+ BOND	21mm	E	E	E					T	M	E	E
ERP-1	CEILING RADIANT PANEL	123N MEN'S WR	208 V	2		0.53	2.6			15A	2c#12+ BOND	21mm	E	E	E					T	M	E	E
ERP-1	CEILING RADIANT PANEL	124N WOMEN'S WASHROOM	208 V	2		0.53	2.6			15A	2c#12+ BOND	21mm	E	E	E					T	M	E	E
P-1	DHW RECIRC PUMP	106E MECHANICAL UTILITY	120 V	1		0.03	0.3			15A	2c#12+ BOND	21mm	E	E	E					T	M	E	E

ABBREVIATIONS

- E - ELECTRICAL SCOPE
- M - MECHANICAL SCOPE
- BAS - BUILDING AUTOMATION SYSTEM
- VFD - VARIABLE FREQUENCY DRIVE
- MAG - MAGNETIC
- T - THERMOSTAT
- TC - TIMECLOCK
- WS - WALL SWITCH

4	ISSUED FOR ADDENDUM #3	JC	JD	2024.11.21
5	ISSUED FOR BUILDING PERMIT	JC	JD	2024.11.05
4	ISSUED FOR RFP	JC	JD	2024.11.01
3	ISSUED FOR 95% CLIENT REVIEW	JC	JD	2024.10.08
2	ISSUED FOR COSTING	JD	TF	2023.11.10
1	ISSUED FOR 50% CD REVIEW	JD	TF	2023.09.01

Issued/Revision By Appd YYYY.MM.DD

File Name: N/A Author: Dwn. Designer: Dgln. Checker: 07/27/23

Permit/Seal



2024.11.21

Stantec Permit: 1002862

Client/Project Logo

Client/Project City of FSJ

FSJ Arena

Title

SINGLE LINE DIAGRAM AND LUMINAIRE/MECHANICAL SCHEDULE

Project No. 115820075 Scale As indicated

Revision 6 Drawing No. E301