PART 1  GENERAL

1.1  DUTIES OF MECHANICAL CONTRACTOR

1.1.1  The mechanical contractor shall assume the responsibilities and duties including but not limited to the ones described below:

1.1.2  Superintendence

1.1.2.1  Provide full time on-site superintendent personnel and supporting staff with proven experience in project of similar value and complexity.

1.1.2.2  Site superintendent shall have over-all authority to speak for and represent the mechanical contractor.

1.1.3  Coordination

1.1.3.1  Coordinate the work with all the General Contractor’s sub-trades involved to ensure that the work will be carried out on schedule and in proper sequence.

1.1.3.2  Take complete responsibility for all remedial work that results from failure to coordinate any aspect of the mechanical work prior to its fabrication and/or installation.

1.1.3.3  Take responsibility for the delivery of equipment necessary to complete the work in accordance with the approved schedule.

1.1.4  Staffing and Scheduling

1.1.4.1  Within seven days after the award of the contract, the Mechanical Contractor shall provide to the Owner representative the following information:

- Appointment of official representatives in the project.
- Schedule of work.
- Delivery schedule for specified equipment.
- Requirements for temporary facilities, site signs, storage, etc.

1.1.5  Work Completion Meeting

1.1.5.1  Prior to application for Substantial Performance of the Work, the mechanical contractor shall participate in the take-over meeting. Agenda to include the following:

- Review of outstanding deficiencies.
1.2 INTENT

1.2.1 Bidders for this work shall include for all labor, material, equipment and all other related cost including all applicable taxes (except GST) and fees to provide a complete hydronic snow and ice melting system consisting of the following components:

- A gas-fired heating plant including boilers, pumps, expansion tanks, glycol fill equipment and accessories.
- Snow and ice melting embedded tubing
- Piping distribution for the heating agent, including manifolds, valves, gauges and accessories.
- Valve and manifold concrete chambers.
- A digital control system to be tied into the Owner’s building automation.
- Ancillary drainage, water make-up and accessories.
- All power supply and control wiring required to make the system fully operational.

1.2.2 The heating plant shall be sized and shall serve the in-floor radiant heating system as well. This document shall be read in conjunction with the Design Guidelines and the In-Floor Radiant Heating specifications. The components of the in-floor radiant heating system are described in the noted section.

1.2.3 All the general provisions and requirements included in this section are applicable to the installation of the in-floor radiant heating system

1.2.4 Misinterpretation of any requirement of the drawings and specifications will not relieve the Mechanical Subcontractor of responsibility. If in any doubt, the Subcontractor shall contact the Consultant for written clarification prior to submitting a bid for the Work.

1.3 CONTRACT

1.3.1 Wherever differences occur between specifications, plans, riser diagrams or schematics and drawings, the maximum conditions shall govern and the bid shall be based on whichever indicates the greater cost.

1.3.2 Field verifications of dimensions on plans shall be made since actual locations, distances, and levels will be governed by actual field conditions.
1.3.3 Discrepancies between different plans, or between plans and actual field conditions, or between plans and specifications shall promptly be brought to the attention of the Consultant for a decision.

1.3.4 Install all mechanical services including but not exclusive to drains, pipes, and ducts, to conserve headroom and interfere as little as possible with the free use of the space through which they pass. All drains, pipes, ducts, etc., particularly those which may conflict with other trades, shall be installed only after the locations have been approved by the Consultant.

1.3.5 Before commencing work, check and verify all grade and invert elevations, levels, and dimensions, to ensure proper and correct installation of the work.

1.3.6 In every place where there is space indicated as reserved for future or other equipment, leave such space clear, install blank offs, shut off valves with blind flanges and other work so that the necessary connections can be made without any stoppages to the system. Consult with the consultant whenever necessary for this purpose.

1.3.7 In addition to the work specifically mentioned in the Specifications and shown on the drawings, provide all other items that are obviously necessary to make a complete working installation, including those required by the Authorities Having Jurisdiction over the work.

1.4 SUBCONTRACTOR'S SHOP

1.4.1 Provide Job site office, work-shop, tools, scaffolds, material storage, etc., as required to complete the work of Mechanical Contractor.

1.5 CODES, PERMITS, FEES AND CONNECTIONS

1.5.1 Conform to Federal, Provincial and Municipal regulations and perform work in accordance with requirements of By-Laws and Regulations in force in area where the work will take place.

1.5.2 Apply for, obtain, and pay for permits, fees and service connections for the mechanical work and the inspections required by Authorities Having Jurisdiction in the area where the work will take place.

1.6 MATERIALS

1.6.1 Where materials, equipment, apparatus, or other products are specified by the manufacturer, brand name, type or catalogue number, such designation is to establish standards of desired quality style or dimensions and shall be the basis of the Bid.
Materials so specified shall be furnished under this Contract, unless changed by mutual agreement.

1.7 **MATERIAL SUBSTITUTIONS**

1.7.1 After execution of the Contract, requests for substitution of materials of makes other than those specifically named in the Contract Documents may be approved by the Consultant.

1.8 **SHOP DRAWINGS AND SAMPLES**

1.8.1 Submit to the Consultant detailed dimension shop drawings and installation wiring diagrams for all mechanical equipment. Further details and special requirements called for in these specifications shall be shown on the shop drawings.

1.8.2 Ensure that copies of all reviewed shop drawings are available on the job site for reference.

1.8.3 Provide samples of mechanical equipment as requested in the specification at the same time as the shop drawing submission.

1.9 **AS-BUILT DRAWINGS**

1.9.1 Maintain up to date "as built" drawings on site and submit to Consultant at completion of the project as specified in this section.

1.9.2 Any subsequent changes found by the Consultant shall remain the responsibility of the Contractor at no charge to GO Transit.

1.10 **CONSULTANT’S INSTRUCTIONS**

1.10.1 During construction the Consultant will issue such instructions as may be necessary for verification and correction of the work. These instructions shall be binding as part of the specification.

1.11 **ADDITIONAL WORK AND CHANGES**

1.11.1 Unless a written order, reviewed by the Consultant and countersigned or otherwise approved by the Owner Representative, no additional work shall be undertaken by the Contractor.
1.12 **WARRANTY**

1.12.1 All plastic snow melting tubes and plastic pre-insulated distribution pipes shall carry a 25 year non-prorated warranty against failure due to defects in material or workmanship.

1.12.2 The complete snow melting system shall be covered by a 2-year warranty against failure due to defects in materials or workmanship. During this period, the system shall be started up and inspected each November, shut off in April of each year and monitored continuously (24/7) via central station by Contractor and/or Supplier.

1.12.3 The complete snow melting system shall be covered by a 10 year limited system performance warranty. This warranty requires that the system detailed design, supervision, commissioning and test witnessing shall be performed by the manufacturers’ authorized personnel along with the Contractor’s Superintendent and the Consultant.

1.12.4 All warranty periods are measured from the date the substantial completion of the system has been confirmed by the consultant.

1.13 **SCHEDULING OF WORK**

1.13.1 For all work to be performed under this contract, adhere to Construction Schedule agreed upon with the General Contractor and the Owner.

1.14 **EQUIPMENT REQUIREMENTS AND INSTALLATION**

1.14.1 Permit equipment maintenance and disassembly by use of unions or flanges to minimize disturbance to connecting piping and duct systems and without interference from building structure or other equipment.

1.14.2 Provide accessible means for lubricating equipment including permanent lubricated bearings.

1.14.3 For all base mounted boilers, pumps, compressors, air handling units, fans and other rotating equipment, provide chamfered edge housekeeping pads a minimum of 4" high and 4" larger than equipment dimensions all around. Work shall be performed by the trades specializing in this work.

1.14.4 Pipe drain lines, overflows and safety relief vents to drains.

1.14.5 Line-up equipment, rectangular cleanouts and similar items with building walls wherever possible.
1.15  THERMOMETERS AND PRESSURE GAUGES

1.15.1 Locate direct reading thermometers and gauges for reading from floor or platform. Provide remote reading thermometers and gauges where direct reading instruments cannot be satisfactorily located.

1.15.2 Thermometers:

1.15.2.1 Industrial, 9" adjustable angle cast aluminum case, CGSB standard CAN/CGSB-14.4-M88 red reading mercury, lens front tube, white scale black embossed figures, clear glass or acrylic window, tapered aluminum stem.

1.15.2.2 Scale shall be suitable for 2 times the temperature range of service. Scale shall be combined Celsius and Fahrenheit.

1.15.2.3 Standard of Acceptance: Weiss, Ashcroft, Trerice.

1.15.3 Pressure Gauges:

1.15.3.1 5" diam. dial, solid front blow out back, fibreglass reinforced polypropylene case, phosphor bronze bourdon tube and brass 1/4" N.P.T. socket, bottom connection, stainless steel rotary type movement, gauge to be registered with the Provincial Boiler and Pressure Vessel Safety Branch with a registration number and conform to ANSI B40.1. Accuracy to be grade "A".

1.15.3.2 On pumps liquid filled gauges shall be utilized.

1.15.3.3 Standard of Acceptance: Weiss, Ashcroft, Trerice.

1.15.3.4 Provide bronze stop cock, bronze bar stock 1/4" N.P.T. bronze porous core pressure snubber for pulsating operation and diaphragm for corrosive service.

1.15.3.5 Use materials compatible with system requirements.

1.15.3.6 Gauges shall have combined kilopascal and psi scales.

1.16  PIPE HANGERS AND SUPPORTS

1.16.1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1-1980.

1.16.2 Anchoring of piping and equipment shall be to manufacturers recommendations. Submit anchorage system, arrangement and type of hangers supports with calculations for review.
1.16.3 For pipes up to 4” diam, approved type expansion shields and bolts may be used. All drilling for hangers, rod inserts and work of similar nature shall be completed by Mechanical Contractor.

1.16.4 Adjustable clevis type hanger: on all sizes of pipes. Use roller type hangers as required. Standard of Acceptance: Myatt, Grinnell.

1.16.5 Adjust full clevis type hanger to MSS-SP58-1979, type 1, ULC listed.

1.16.6 For all non-copper pipes, typical Grinnell figure 260. For all copper pipes, use copper plated, Grinnell figure CT-65.

1.16.7 Space support within 12” of each horizontal elbow. Provide hanger within 18” on each side of valve or tee.

1.16.8 Hangers shall be 3 piece minimum standard i.e. attachment, rod, pipe attachment. Mild steel wall hooks may be used to support non-expanding piping. Allow 1” minimum clearance for insulated pipe.

1.16.9 On un-insulated copper piping, use Teflon coated hangers. Provide saddles for all insulated pipes and prefabricated insulation shields with high density insulation with vapour barriers for domestic cold water and chilled water piping. Standard of Acceptance: Grinnell Saddles 160 or 165, Grinnell Shields 167; Myatt: Apex.

1.17 **TESTS**

1.17.1 Do not insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests. Conduct tests in presence of Consultant. Bear costs including retesting and making good.

1.17.2 Pipe pressure: Hydraulically test piping systems at 1.5 times system operating pressure or minimum 860 kPa, whichever is greater. Maintain test pressures without loss for 4h unless otherwise specified.

1.17.3 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

1.18 **PAINTING**

1.18.1 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

1.18.2 Touch-up paint all damaged equipment with products matching original finish in quality and appearance.
1.18.3 Paint the entire gas line where applicable with two coats of yellow paint.

1.19 SPECIAL TOOLS AND SPARE PARTS

1.19.1 Furnish spare parts as follows:

1.19.1.1 One set of packing for each pump.
1.19.1.2 One glass for each gauge glass installed.
1.19.1.3 One set of v-belts/bolts for each piece of machinery.
1.19.1.4 One spare set of filters for each filter bank installed.

1.19.2 Upon completion of project and immediately before hand-over, replace all filters.

1.20 DIELECTRIC COUPLINGS

1.20.1 Provide wherever pipes of dissimilar metals are joined.

1.21 INSTRUCTION OF OPERATING STAFF

1.21.1 Supply certified personnel to instruct GO Transit operating staff on operation of new mechanical equipment. Supply maintenance specialist personnel to instruct operating staff on maintenance and adjustment of mechanical equipment and any changes or modification in equipment made under terms of warranty.

1.21.2 Provide min. 4 hrs of instruction time during regular work hours prior to acceptance and turn-over to operating staff for regular operation. This does not include training on digital control system, which is covered under section 15900.

1.21.3 Use operation and maintenance data manual for instruction purposes. On completion of instruction, turn manuals over to the Consultant.

1.21.4 Scheduling of the timing for the training of the operating staff shall be arranged with GO Transit representatives 10 days prior to the completion of the project.

1.22 MAINTENANCE MANUALS

1.22.1 Provide minimum of four (4) copies of Mechanical Maintenance Manuals. Mechanical Maintenance Manuals to be delivered to the Consultant's office 10 days prior to the substantial completion of the Contract.

1.22.2 Manuals to be bound in a hard cover neatly labeled: "OPERATING AND MAINTENANCE INSTRUCTIONS".
1.22.3 The Maintenance Manuals shall be divided into sections with neatly labeled and tabbed dividers between each section. The sections to be included in the manual are:

1.22.3.1 Section I - General.
1.22.3.2 Section II – Metallic Piping and Pump Systems, Plumbing Fixtures.
1.22.3.3 Section III – Snow and ice melting plastic tubing/In-floor radiant heating tubing
1.22.3.4 Section IV - Automatic Controls.
1.22.3.5 Section V - Hydronic Balancing Reports

1.22.4 The following information shall be contained within the sections:

1.22.4.1 SECTION I: A list giving name, address and telephone number of the Consultant, Engineers, and General Contractor, Mechanical Trade and Controls Trade. Warranty certificates for the Mechanical Systems. A copy of the Valve directory giving number, valve location, normal valve position, and purpose of valve (a framed copy of Valve Directory to be hung in the boiler room). Equipment lists and certificates shall be provided - certificates shall be signed and sealed by the appropriate suppliers.

1.22.4.2 SECTION II, III: A copy of all pressure tests and operational tests. A copy of Gas Operational Tests for gas fired equipment. A list giving name, address and telephone number of all suppliers. A copy of all reviewed Shop Drawings for the mechanical equipment.

1.22.4.3 SECTION IV: Complete Control Diagrams, Wiring Diagrams and description of Control system and the functioning sequence of the system. For details, refer to section 15900

1.22.4.4 SECTION V: Complete results of the hydronic balancing (for report formatting, refer to section 15015).

1.23 CONCRETE

1.23.1 All concrete work required to complete this project, whether shown on the drawings or not, shall be the Contractor's responsibility.

1.24 METALS

1.24.1 All steel construction required for the completion of this project, whether shown on the drawings or not, shall be the Contractor's responsibility.
1.25 CUTTING, PATCHING, ROOFING AND X-RAY

1.25.1 All cutting, patching, roofing and X-Rays required for the completion of this project whether shown on the drawings or not, shall be the Contractor’s responsibility. The cutting and patching work shall be performed in accordance with the following:

1.26 PERFORMANCE TESTS AND EQUIPMENT START-UP

1.26.1 After all equipment has been installed, adjusted, balanced and started up, subject equipment to a series of performance tests, as soon as conditions permit.

1.26.2 The timing of the tests shall be arranged to suit the convenience of the Consultant, and the manner and duration shall be as the Consultant deems necessary. Record the daily start and stop times, operating hours and functions performed. Ensure that the performance tests are witnessed by the Consultant.

1.26.3 All major equipment including but not limited to boilers, coils and pumps, are to be inspected by the manufacturer to ensure that the equipment has been installed in accordance with their recommendations.

1.26.4 Operate equipment under varying load conditions, demonstrate start-up sequence, normal shutdown, simulated emergency shutdown, operation of temperature, etc., and safety controls. Operate switches and electrical devices for correct wiring sequences. Adjust components to achieve a proper functional relationship among all the components of all the systems. Repeat these functions as many times as deemed necessary by the Consultant to achieve reliable operation.

1.26.5 Repair defects and repeat tests as necessary. During test maintain lubrication schedule, set, align and tension drives.

1.26.6 At the successful completion of Performance Tests and all testing and balancing, make the systems ready for final inspection and subsequent acceptance of Go Transit. Replace and clean filters, flush out lines and equipment, remove and clean strainers, fill liquid systems and purge air. Disinfect all domestic water as required by current by-laws and Authorities Having Jurisdiction.
PART 1  GENERAL – DESIGN CRITERIA

1.1  DESIGN CRITERIA

1.1.1  This document contains the design guidelines and specifications for the supply and installation of a class 3 hydronic snow and ice melting system for Go Transit.

1.1.2  Related Documentation: This document shall be read and applied in conjunction with the GO Transit/Metrolinx In-Floor Radiant Heating Design Guidelines and Specifications.

1.1.3  A class 3 snow and ice melting system is capable of melting the snow as fast as falls and quickly evaporate it so that the surface is dry at the end of the cycle.

1.1.4  The heat requirement shall be determined by rate of snowfall, dry bulb temperature, humidity, wind speed and apparent sky temperature. This information is available from the National Climate Data Center or other publications such as the ASHRAE Handbooks.

1.1.4.1  Example: For the Toronto area, the typical design climatic data considered shall be: -4°F (-20°C) outdoor temperature, 20 mph (32 km/hr), estimated maximum hourly rate of snowfall 1.1 to 1.8"/hr (2.8 to 4.5 cm/hr). Under such circumstances, the typical value for a class 3 snow and ice melting system serving an unsheltered surface in the Toronto area is between 185 and 200 BTU/sq.ft. (Roads and Transportation Association of Canada).

1.1.5  The hydronic snow and ice melting system uses multiple hot fluid tubes embedded in (or under) the surface required to be clean of ice. The temperature differential between the hot fluid entering and leaving the area to be protected should not exceed 25°F (14°C) to avoid thermal shock.

1.1.6  The flow of hot fluid shall be determined by selecting a pipe velocity of between 3 and 5 ft/s (1 to 1.5 m/s) to avoid excessive pressure drop and pipe erosion.

1.1.7  The fluid to be used shall contain sufficient inhibited antifreeze to maintain the solution in a pumpable fluid state at least 5°F (3°C) below the lowest anticipated ambient air temperature. A non-toxic antifreeze such as food-grade propylene glycol shall be used.

1.1.8  In applications where the end-user is comfort radiant floor equipment and no snow melting equipment is required, the fluid to be used shall be water.

1.2  EMBEDDED PLASTIC TUBING

1.2.1  The snow melting tube spacing will depend on tube diameter and anticipated heat output. Typically, class 3 snow and ice melting systems require ½" diam. tubing spaced
at 4” on center; larger, ¾” tubes may be spaced wider. For accurate spacing and tubes diameters, and for installation procedures, consult the manufacturer’s literature.

1.2.2 The snow and ice melting system shall be designed to “idle” during no-snow condition, maintaining the protected surface at a temperature just above freezing. It is desirable to use the earth beneath the protected surface as a heat sink, by installing vertical insulation at the edges of the surface, down min. 4 ft (1.2 m).

1.2.3 There will be no splicing of plastic tubing; each circuit shall be contiguous. The layout of circuits shall take into account the configuration of area to be protected, any expansion joints, column footings, etc. If located directly below asphalt, circulate domestic cold water at a rate of 1 gpm per circuit, until the asphalt surface cools to 150°F (65°C).

1.3 HEATING PLANT

1.3.1 The heat source for the snow and ice melting system shall be a gas-fired boiler plant that shall include a pair of boilers, each sized at 60% of the total heating demand.

1.3.2 The total heating demand shall be defined as the sum of:

1.3.2.1 The total heating demand of the snow melting system.
1.3.2.2 The total heating demand of the indoor radiant heating system

1.3.3 The piping arrangement shall contain a primary loop and two secondary loops as follows:

1.3.3.1 The primary loop shall circulate the heating fluid through the boilers, ensuring that they remain hot and no thermal shock will occur. The average temperature of the primary loop shall not drop below 130°F (adjustable), with a differential between supply and return of 25°F. Fluid circulation in the primary loop shall be provided by:

- In-line circulators (one per boiler) for total primary loop fluid flows of 200 gpm or less. Each pump assembly to include a strainer upstream, a balancing valve downstream and pressure gauges on the suction and discharge sides. Pumps to be interlocked with the boilers serve.
- Vertical-in line centrifugal pumps working in a lead/lag sequence for primary loop total fluid flow in excess of 100 gpm (each pump sized for the full flow of the primary loop). Each pump shall be equipped with a suction guide and a discharge triple-duty valve.

1.3.3.2 One secondary loop serving the snow melting system. This loop shall interface with the primary loop via a 4-way mixing valve. Fluid circulation in the
The snow and ice melting plastic tubes circuits shall be connected to brass manifolds, each circuit equipped with independent supply and return isolation valves. The manifolds shall be located in recessed chambers, fully accessible; the number of chambers shall be determined by the area of the surface to be served and the respective number of circuits. The typical manifold can supply up to 12 circuits, with the length of each circuit not exceeding 200 ft (60 m).
1.4.2 The number of manifolds contained in each chamber shall be limited not only by the number and lengths of tubing circuits, but also by the physical size and depth of the chamber, which should not be classified as a confined space. Adequate maintenance clearances shall be provided around the manifolds and valves.

1.4.3 All hot fluid piping inside the manifold chamber shall be copper, adequately insulated and identified. Each manifold chamber shall have general shut-off valves, capable of isolating the contained manifolds.

1.4.4 Piping drainage ports, equipped with isolation valves shall be provided at the low points. Adequate means of drainage shall be provided, to ensure that any leak in the manifold chambers will be disposed of by gravity.

1.4.5 Each manifold chamber shall be equipped with a metallic lockable access hatch, equipped with recessed handles.

1.5 HOT FLUID UNDERGROUND DISTRIBUTION

1.5.1 All underground hot fluid distribution between the boiler plant and the manifold chambers, or between various chambers shall be through pre-insulated flexible piping installed in scheduled 40 PVC sleeves; bell and spigot of sleeves to be oriented in the direction of flow through the pre-insulated pipes. Due to its all-plastic construction, the pre-insulated pipe compensates for thermal movement and there is no requirement for expansion joints. The sleeves shall be 2 diameter sizes larger than the combined diameter of the flexible piping, insulation and protection jacket, and buried at a depth suitable for the surface above (pedestrian traffic, vehicular traffic, track right of way, etc).

1.5.2 Due to diameter limitations of the pre-insulated piping, multiple circuits may be required between the boiler plant and the manifold chambers, to limit the hot fluid velocity at 3 to 5 ft/s (1 to 1.5 m/s).

1.5.3 When leaving the boiler plant and entering the manifold chambers, the pre-insulated piping and associated sleeves will respect the minimum bending radiiuses recommended by the manufacturer. Manufacturer-supplied connectors and unions shall be provided where the pre-insulated plastic piping connects to the copper piping in the boiler room and manifold chambers.

1.6 DIGITAL CONTROLS

1.6.1 The operation of the snow and ice melting system shall be controlled by the Owner’s digital control system. To this end, sensors, operators and controllers shall be provided to match the sequence of operation noted in the specifications.
1.6.2 The digital control system shall be capable to tie into the GO Transit/Metrolinx WAN and interface with the Owner designated main server.

1.6.3 Wiring between the snow and slab mounted sensors and the boiler plant shall be located in a separate 4” diam. schedule 40 PVC sleeve, running parallel to the hot fluid distribution piping.

1.6.4 For installation and wiring details of the snow melting sensor, refer to the Snow Melting Sensor Installation (detail S-101) attached to this document.

PART 2 GENERAL CONDITIONS

2.1 BOILERS

2.1.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

2.1.2 This section of the specification shall be read in conjunction with the GO Transit/Metrolinx specifications for radiant in-floor heating.

2.1.3 Reference Standards


2.1.3.2 The boiler performance shall conform to the requirements outlined in ASHRAE 90.1 and the requirements outlined by the Ministry of the Environment.

2.1.4 Shop Drawings

2.1.4.1 Submit shop drawings in accordance with Section 15010.

2.1.5 Maintenance Data

2.1.5.1 Provide maintenance data for incorporation into maintenance manual as specified in Section 15010.

2.1.6 Warranty

2.1.6.1 Refer to the applicable paragraph in section 15010.
2.2 HEPEX SNOW MELTING TUBING

2.2.1 References

2.2.1.1 Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

2.2.1.2 ASTM International

- ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops
- ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing
- American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL)

2.2.1.3 Canadian Standards Association (CSA)

- CAN/CSA B137.5 Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications

2.2.2 System Description

2.2.2.1 Standard Grade hydrostatic pressure ratings from Plastics Pipe Institute in accordance with TR-3 as listed in TR4.

2.2.2.2 The following three standard grade hydrostatic ratings are required.

- 200 degrees F (93 degrees C) at 80 psi (551 kPa)
- 180 degrees F (82 degrees C) at 100 psi (689 kPa)
- 73.4 degrees F (23 degrees C) at 160 psi (1102 kPa)
2.2.2.3 Certification of flame spread/smoke development rating of 25/50 in accordance with ASTM E84 for the following PEX tubing sizes when encased with ½ inch fiberglass insulation at tube spacing of not less than 4 inches apart.

- 5/16 inch [7.94mm]
- ⅛ inch [9.53mm]
- ⅛ inch [12.7mm]
- ⅜ inch [15.88mm]
- ¼ inch [19.05mm]
- 1 inch [25.4mm]
- 1 ¼ inch [31.75mm]
- 1 ½ inch [38.1mm]
- 2 inch [50.8]

2.2.2.4 Performance Requirements

- Provide hydronic snow and ice melting system that is manufactured, fabricated and installed to comply with regulatory agencies and authorities with jurisdiction, and maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.

- Show compliance with ASTM F877

- Show compliance with DIN 4726 regarding oxygen diffusion concerns where applicable

- Show compliance with ASTM E119 and ANSI/UL 263 through certification listings with Underwriters Laboratories, Inc. (UL).

2.2.3 Submittals

2.2.3.1 Submit listed submittals in accordance with section 15010

2.2.3.2 Product Data:

- Submit manufacturer’s product submittal data and installation instructions

2.2.3.3 Shop Drawings

- Provide installation drawings indicating tubing layout, manifold locations, zoning requirements and manifold schedules with details required for installation of the system.
- Provide mechanical schematic indicating heat source, mechanical piping and accessories from heat source to manifolds, circulators, water tempering and zone controls. Indicate supply water temperatures and flow rates to manifolds.

- Samples: Submit selection and verification samples of piping.

2.2.3.4 Quality Assurance and Control Submittals: Submit the following.

- Test Reports: Upon request, submit test reports from recognized testing laboratories.

2.2.3.5 Documentation: Submit the following.

- Manufacturer’s certificate indicating products comply with specified requirements
- Manufacturer’s detailed room-by-room heat-loss analysis for the structure
- Documentation indicating the installer is trained to install the manufacturer’s products

2.2.3.6 Closeout Submittals: Submit the following.

- Warranty documents specified herein
- Operation and maintenance data
- Manufacturer’s field reports specified herein
- Final as-built tubing layout drawing

2.2.4 Quality Assurance

2.2.4.1 Installer Qualifications:

- Use an installer with demonstrated experience on projects of similar size and complexity and possessing documentation proving successful completion of snow and ice melting training by the PEX tubing manufacturer.
2.2.4.2 Certifications: Provide letters of certification as follows.

- Installer is trained by the PEX tubing manufacturer to install the snow and ice melting system.

- Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed tradesperson.

2.2.4.3 Pre-installation Meetings

- Verify project requirements, substrate conditions, floor coverings, manufacturer’s installation instructions and warranty requirements

- Review project construction timeline to ensure compliance or discuss modifications as required

- Interface with other trade representatives to verify areas of responsibility

- Establish the frequency and construction phrase the project engineer intends for site visits and inspections by the PEX tubing manufacturer’s representative

2.2.5 Delivery, Storage And Handling

2.2.5.1 Comply with manufacturer’s ordering instructions and lead-time requirements to avoid construction delays.

2.2.5.2 Delivery: Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.

2.2.5.3 Store PEX tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.

2.2.5.4 Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

2.2.6 Warranty

2.2.6.1 Warranty shall be as described in section 15010.

2.2.6.2 Warranty covers the repair or replacement of any tubing or fittings proven defective.
2.2.6.3 Warranty Period for PEX Tubing: 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained Uponor Home Comfort Team (HCT) contractor.

2.2.6.4 Warranty Period for Manifolds and Fittings: 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained Uponor HCT contractor.

2.2.6.5 Warranty Period for Controls and Electrical Components: 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained Uponor HCT contractor.

2.2.6.6 If a factory-trained Uponor HCT contractor does not install the system, then the most recent limited warranty published by the PEX tubing manufacturer takes precedence.

2.2.7 Owner Training

2.2.7.1 Train Owner’s personnel about operation and maintenance of installed system. Provide manufacturer’s installation, operation and maintenance instructions for installed components within the system.

2.2.8 Standard Of Acceptance

2.2.8.1 Upnor, Wirsbo, Stadler, Roth

2.2.9 Product Substitutions

2.2.9.1 All products, components, etc., specified herein are manufactured by and/or available from the PEX tubing manufacturer.

2.2.9.2 Alternative equipment manufacturers must submit required data for all electrical, mechanical, structural, engineering, etc. revisions for an equivalent system for approval 15 days prior to bid.

2.2.9.3 Alternative equipment manufacturers must submit completed radiant floor design layout to the project engineer for approval. Plagiarism of another manufacturer’s design is unacceptable.
2.3 **PUMPS**

2.3.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

2.3.2 Related documents: Go Transit/Metrolinx specifications for In-Floor Radiant Heating

2.3.3 **Shop Drawings**

2.3.3.1 Submit shop drawings in accordance with Section 15010.

2.3.3.2 Submit shop drawings of pump curves for review.

2.3.3.3 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

2.3.4 **Maintenance Data**

2.3.4.1 Provide maintenance data for incorporation into maintenance manual specified in Section 15010.

2.3.5 **Warranty**

2.3.5.1 Refer to section 15010

2.4 **TESTING, ADJUSTING AND BALANCING (TAB)**

2.4.1 **Description**

2.4.1.1 Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

- Systems Inspection report.
- Balancing water and glycol distribution systems; adjustment of total system to provide design performance;
- Recording and reporting results.

2.4.2 **Definitions**

2.4.2.1 TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.

2.4.2.2 AABC: Associated Air Balance Council.
2.4.2.3 Hydronic Systems: Includes heating hot water, domestic hot water recirculation, chilled water, condenser water, and glycol water systems, as applicable to the project.

2.4.2.4 Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

2.4.3 Quality Assurance

2.4.3.1 Qualifications:

- TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.

- The TAB agency shall be either a certified member of AABC to perform TAB service for HVAC and water balancing equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Consultant and the Owner and submit another TAB firm for approval.

- TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency.

2.4.3.2 TAB Agency shall be identified by the General Contractor within 10 days after the award of the contract.

2.4.3.3 The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Consultant. The responsibilities would specifically include:

- Shall directly supervise all TAB work.
- Shall sign the TAB reports that bear the seal of the TAB Agency. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC.
- Would follow all TAB work through its satisfactory completion.
- Shall provide final markings of settings of all HVAC adjustment devices.

2.4.3.4 Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards and or by the instrument manufacturer.
2.4.3.5 Flow rate tolerance:

- Pumps and manifolds: +/-5%
- Individual snow melting/radiant floor heating circuits: +/-5%.

2.4.4 Submittals

2.4.4.1 Submit Following for Review to the Consultant:

2.4.4.2 Systems inspection report on equipment and installation for conformance with design.

2.4.4.3 Final TAB reports covering flow balance and adjustments, performance tests.

2.4.4.4 Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.

2.4.5 Applicable Publications

2.4.5.1 The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.

2.4.5.2 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE): HVAC Applications ASHRAE Handbook, Testing, Adjusting, and Balancing

2.4.5.3 Associated Air Balance Council (AABC): AABC National Standards for Total System Balance

2.5 DIGITAL CONTROLS

2.5.1 Intent

2.5.1.1 The intent is to supply, install, test and commission a complete microprocessor-based programmable control system including all components as described herein and as necessary to make the snow-melting system operate in accordance with the sequences described in these specifications.

2.5.1.2 The system shall provide seamless interface with LONWORKS and BACNET such that the operation of the new snow melting system may be controlled, monitored and adjusted remotely or locally.
2.5.1.3 The system shall have access to the GO Transit/Metrolinx main server using the available WAN. Operators using the main server shall have full access to the BAS software, graphical user interface at each location and shall have the ability to communicate with the local control panels to adjust parameters, modify schedules, receive alarms, etc.

2.5.1.4 Local workstations shall mirror the Graphical User Interface available on the main server and show on a read-only basis the operating parameters of the systems.

2.5.1.5 Full access to the BAS parameters, schedules and programming shall be available through local control panels connectors to specialized GO Transit/Metrolinx staff using portable computers (laptops, notebooks or similar).

2.5.1.6 Provide a Facility Management and Control System incorporating LonWorks open protocol, BACNET Compatible Direct Digital Control, equipment monitoring, and control consisting of microprocessor based plant control processors interfacing directly with sensors, actuators, and environmental delivery systems (i.e. HVAC units); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, sensing devices; a primary communications network to allow data exchange between microprocessor based devices. The system shall match the existing Direct Digital Control systems to ensure continuity and ease of operation and maintenance. Standalone electronic systems that do not allow connectivity to a Wide Area Network with Central Server and remote client workstations are not acceptable.

2.5.1.7 The system will consist of a open architecture that utilizes the LonTalk protocol as the common communication protocol between all controlled and controlling devices, and LNS architecture for the definition of the device database. When necessary or desired, LonTalk packets shall be encapsulated into TCP/IP messages to take advantage of existing infrastructure and allow connection to Local Servers for graphic displays and alarm handling or the Central Server as required.

2.5.1.8 The system network shall be an Echelon Local Operating Network (LON). All nodes shall communicate with each other over one or more channels utilizing one of the LonMark approved transceivers (Type 1 – FTT-10A, Type 2 – Twisted Pair). There will be no consideration given to any system that does not use LonWorks as the primary communications network. System controllers shall be capable of sharing standard network variable data with other LonWorks based devices that utilize the same transceivers.
2.5.1.9 The system installed shall be able to seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e. HVAC and lighting shall coexist on the same network channel without the need for gateways. These components shall share common software for network communications, configuration, time scheduling, alarm handling, history logging, custom programming and monitoring.

2.5.1.10 System Monitoring and Supervisory Control shall be provided through a Web Server or as required a Central Server. The Web Server shall be accessible using standard web browser software and shall be access restricted to authorized users only. The Web Server shall match those existing to ensure a standardized installation including displays and alarm handling.

2.5.1.11 The control system shall include the necessary engineering, supervision and programming, to form a complete operational system.

2.5.2 Shop Drawing Submittals

2.5.2.1 Prepare and submit three (3) copies of shop drawing manuals for the review and approval of the Consultant. Under no circumstances shall the Controls Contractor commence site work prior to the receipt of approved shop drawings.

2.5.2.2 The shop drawing submittal shall include the following:

- Control schematics for each system
- Detailed sequence of operation for each controlled system.
- System Architecture indicating the type and model number for all BAS components, the proposed interconnection and location of all panels, network connection and key peripheral devices (workstations, modems, printers, repeaters, etc)
- BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e. AO/DO/AI/DI), end device fail position, end device manufacture and model number and wire tag ID.
- Provide a list of field labels (i.e. labels/oids) with proposed software names and point descriptions.
- Wiring diagrams including complete power system, interlocks, control and data communications.
- Programming code listing for all controllers
- Manufacturers’ data/specification sheets and catalogue cuts for all material and equipment supplied.
- Automatic control devices and sensors.
2.5.3 As-Built Documentation

2.5.3.1 Prepare and submit one (1) copy of BAS As Built and Operating/Maintenance manuals to the Consultant for review and acceptance.

2.5.3.2 Receive one (1) hard copy and one (1) CD of the final mechanical documentation from the mechanical consultant for insertion into a combined BAS-Mechanical manual.

2.5.3.3 Once the BAS As-Built documentation has been accepted by the Consultant, combine the mechanical final documentation with the BAS documentation. Prepare and make up five (5) copies of the combined BAS-Mechanical documentation manuals and submit them at the project turn-over meeting.

2.5.3.4 The BAS contractor shall provide a CD with each manual to include all of the As Built Documentation contained within the manual (mechanical documentation, fixture cuts, operating/maintenance procedures, warranties, letters, graphics, points lists, programming, sequences etc.) and shall also include As Built drawings in Autocad format. The owner will supply electronic copies of the original tender BAS drawings to the BAS contractor.

2.5.3.5 The As-built documentation shall include the following:

- Building and address
- A brief description of the control details. i.e. total # of points, list of equipment controls and the panels to which they a connected.
- Panel’s information i.e. part numbers for panels used and there serial numbers and revision # (if applicable).
- Software version.
- BAS/Owner’s WAN IP address.
- Warranty start date and duration.
- BAS contractor Name, address, and Phone number.
- Detailed sequence of operation for each controlled system.
- Control schematics for each system. Including a System Architecture indicating the type and model number for all BAS components, the proposed interconnection and location of all panels, network connection and key peripheral devices (workstations, modems, printers, repeaters, etc)
- BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e. AO/DO/AI/DI), end device fail position, end device manufacture and model number and wire tag ID.
- Floor plan with the location of all field mounted control devices.
- Programming code for all DDC controllers
- Wiring diagrams including complete power system, interlocks, control and data communications.
- Manufacturers’ data/specification sheets and catalogue cuts for all material and equipment supplied including the workstation PC (where applicable) and any equipment (e.g. valves, starters, VFDs, etc.) supplied under the mechanical scope of work. This section shall include a summary sheet that indicates all BAS Device, Manufacturers’, model number, and quantity of each used on this job.
- Automatic control devices and sensors
- Electrical Authority Inspection Certificates – General Inspection and Product Approval Inspection.
- Licensed BAS workstation software.
- BAS programming database stored on a CD-R disk.
- Workstation PC documentation, original Windows operating system/recovery disks, licenses, and warranty (where applicable)

2.5.4    Warranty

2.5.4.1    All labour and material (hardware and software) supplied under this contract shall be warranted free from defects for a period of two (2) years after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost to the Owner. The Contractor shall respond to Owner’s request for warranty service within one (1) business day.

2.5.4.2    The final completion and acceptance date shall be the date of the project turnover meeting.

2.5.4.3    All work shall have a single warranty date, even when the Owner has received beneficial use of part of the system in advance of the final completion date.

2.5.4.4    The contractor shall be responsible for correcting any deficiencies, errors or omissions in operating strategies, programming code, system functionality or parameters and operator workstation graphics during the warranty period.

2.5.5    Ownership Of Proprietary Material

2.5.5.1    All project-developed software and documentation shall become the property of Go Transit/Metrolinx. These include, but are not limited to:

- Project graphic images
- Record drawings
- Project database
- Project application programming code
2.5.6 Standard Of Acceptance

2.5.6.1 The following vendors shall be accepted to supply the controls equipment:

- Siemens
- TA Canada
- Automated Logic Controls

PART 3 PRODUCTS

3.1 BOILERS

3.1.1 General

3.1.1.1 Boilers approved to ANSI Z21.13 CSA 4.9-2000 standards with minimum efficiency of 85.2%. Efficiency shall be up to 88.5% with 125°F supply water. Boilers shall have no limit on inlet water temperatures.

3.1.1.2 Boilers shall be constructed of eutectic cast iron sections manufactured in accordance with ASME requirements for low-pressure boilers and each section shall be permanently marked with the ASME symbol and the maximum allowable working pressures. The eutectic cast iron shall have a modulus of elasticity of 30% greater than other cast iron. The warranty on boilers should not be affected if flue gas condensation is allowed within the boiler.

3.1.1.3 Boilers and burners shall be listed as a package, site approval not acceptable. Boiler and burner package must have proven field verified track record for a period of 3 years minimum.

3.1.1.4 The boilers shall be capable of operating at 125°F fluid outlet temperature, with no lower limit on inlet fluid temperature.

3.1.1.5 The boiler warranty shall not be affected if flue gas condensation enters inside the boiler sectional elements.

3.1.1.6 The boiler manufacturer shall have a facility in Ontario; qualified manufacturing/combustion technicians and spare parts shall be readily available within the GTA region.

3.1.1.7 Capacity, performance and power supply: as indicated in the equipment schedules.
3.1.2 Boiler Construction

3.1.2.1 Boilers shall be of a three pass wet base, wetbacks design with optimized fins and cast iron turbulators to permit greater heat transfer. The forced draft burner shall be capable of firing the boilers pressurized combustion chamber assuring proper draft and positive ventilation. The burner shall be mounted to swing open either left or right on hinged mounting plate.

3.1.2.2 Boiler sections shall be assembled with precision-machined bi-spherical push nipples pressed into mating machinery nipple port in the section. A gas tight seal with the use of a siliconed thermocord sandwiched between sections prevents leakage of flue gases. The boiler shall be complete with a drain tapping and drain valve. Boilers shall be complete with full-swing doors that give access to all flue ways and combustion areas for easy maintenance and cleaning without burner removal.

3.1.2.3 The complete boiler including the bottom shall be insulated with a minimum thickness of four inches of reinforced fiberglass wool insulation, and shall be encased in a heavy gauge steel boiler jacket. This jacket shall be installed after system piping has been connected to the boiler section assembly. Jacket will have removable panels to allow access to the boiler as required.

3.1.2.4 Water boiler trim shall include pressure gauge, temperature gauge, low water cut-off high limit control operating control, high fire control, and drain valve. An ASME approved pressure relief valve shall be furnished sized to exceed the boiler gross output capacity and shall be factory set to relieve pressure at 125 PSI.

3.1.2.5 The boiler/burner shall be pre-wired to provide the following operation:

- Local - Remote switch on burner.
- In Remote position burner shall be capable of being controlled from the digital control system.
- In Local position burner shall operate from supplied controls.

3.1.2.6 All control circuits shall be 120V/60Hz/1Ph. with all switches in the ungrounded leg. Fuse protection for the control circuit shall be provided.

3.1.2.7 Boiler controls shall be housed in a factory pre-wired control cabinet. The cabinet shall house combustion Safeguard Control to provide pre-purge, post-purge and burner sequencing, complete with flame rod.
3.1.2.8 Panel shall include the following:

- All panel wiring with color-coded wire.
- Motor starters with overload protection for blower motor.
- On/off switch.
- Low/auto switch.
- Step down transformer for 120-volt output. With circuit fuse if power supply is 3 phase.
- Individual pilot lights with nameplated to indicate: "Power On", "Main Fuel Valve On", and "Flame Failure".

3.1.2.9 Electronic safety combustion controls shall be supplied to monitor pilot and main flame. Detection will be means of a flame rod. The programming control shall be by Honeywell and will provide pre and post purge, trial for ignition, energize main fuel circuit, interrupted tupe pilot and sequence operation.

3.1.2.10 Manual restart of each burner shall be necessary in the event of a shutdown due to flame failure.

3.1.2.11 Standard of Acceptance:

- De Dietrich GT series
- Viessmann Vitorond series

3.1.3 Burner Construction

3.1.3.1 The fully modulating linkage-less burner shall be provided by the boiler manufacturer and selected to match the boiler capacity indicated on the equipment schedule. Burner shall include squirrel cage 3,450 rpm motor, shall be factory tested and incorporated all necessary devices and controls to make a complete fuel burning system and bear the listing label of CSA.

3.1.3.2 The burner shall be designed for natural gas and be of the forced-draft pressure-atomizing type with no CO present in the products of combustion. The burner shall be furnished with an integral motor-driven blower, stainless steel flame retention type combustion head and observation port, and a primary control which utilizes a UV scanner.

3.1.3.3 Burner modulation must be done by linkage-less means by use of independent actuation of the fuel valve and air damper (no mechanical linkages shall be used). Linkage-less control system by Honeywell.
3.1.3.4 Gas Train

- Main gas pressure regulator, (vented to outside atmosphere, in accordance with local codes), approved automatically operated motorized safety gas shutoff valve, with proof of closure interlock switch, second automatically operated gas safety valve, manually operated gas shutoff valve located downstream of both automatic gas valves (to permit leakage testing of valves), test pressure tappings upstream and downstream of each valve and regulator, air damper with linkage-less modulating control. A separate pilot gas cock, gas pressure regulator, solenoid valve shall be provided. The pilot will be spark ignited.

- Boiler/Burner Controls shall be housed in a factory pre-wired control cabinet. The cabinet shall house combustion Safeguard Control to provide pre-purge, post-purge and burner sequencing, complete with flame rod. Panel shall include the following:
  - All panel wiring with color-coded wire.
  - Motor starters with overload protection for blower motor.
  - On/off switch.
  - Low/auto switch.
  - Step down transformer for 120-volt output. With circuit fuse if power supply is 3 phase.
  - Individual pilot lights with name-plated to indicate: "Power On", "Main Fuel Valve On", and "Flame Failure".

- Electronic safety combustion controls shall be supplied to monitor pilot and main flame. Detection will be means of a flame rod. The programming control shall be a Fireye, model MC120 and will provide pre and post purge, trial for ignition, energize main fuel circuit, interrupted tube pilot and sequence operation.

- Manual restart of each burner shall be necessary in the event of a shutdown due to flame failure.

3.1.3.5 Standard of Acceptance

- Riello RSM series
- Fuelmaster
- Weishaupt

3.2 HEPEX SNOW MELTING TUBING
3.2.1 Section Includes: Hydronic snow and ice melting systems for various slab constructions and control strategies, using cross-linked polyethylene (PEX) tubing and applicable fittings.

3.2.2 Material: Cross-linked polyethylene (PEX) manufactured by the Engle method

3.2.3 Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third-party agency.

3.2.4 Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI).

3.2.5 Show compliance with ASTM E119 and ANSI/UL 263 through certification listings through UL.

3.2.6 Minimum Bend Radius (Cold Bending): No less than six times the outside diameter. Use the PEX tubing manufacturer's bend supports if radius is less than stated.

3.2.7 Oxigen Diffusion Barrier

3.2.7.1 The oxygen diffusion barrier does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.

3.2.7.2 Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated.

- ½ inch [12.7mm]
- ¾ inch [19.05mm]
- 1 inch [25.4mm]

3.2.8 Heating Agent Distribution Piping

3.2.8.1 Section Includes: all piping between the exterior wall of the boiler room and the interior wall of the distribution manifolds chamber(s).

3.2.8.2 All piping between the interior wall of the manifold chamber and the manifolds themselves shall be in accordance with section 15706

3.2.8.3 System Description

- Pre-insulated pipe system for buried commercial hydronic heating applications.
- Service pipes are made from durable “Engel-method” crosslinked polyethylene (PEX-a) tubing and protected by multilayer PEX-foam insulation and covered by a corrugated, waterproof HDPE jacket. The system can use Uponor ProPEX® fittings or WIPEX™ dezincification-resistant (DZR) brass compression fittings. Saline and electronic cross linking methods are not acceptable.

3.2.8.4 Service Pipe:

- Cross linked polyethylene (PEX-a) Engel-method tubing with an EVOH oxygen barrier that conforms to German DIN 4726; smoothness value of 0.02 mil; NSF certified SDR-9

3.2.8.5 Insulation:

- Multilayered, closed-cell, PEX-foam insulation with a thermal conductivity of 0.26 BTU in./sq. ft./hour/°F; vapor permeability of 0.1g/100 sq. in./day

3.2.8.6 Jacket:

- Corrugated seamless high-density polyethylene (HDPE), UV-protected

3.2.8.7 Operating Limits:

- -58°F to 203°F (-50°C to 95°C) at 87 psig

3.2.8.8 Pipe Sizes: 1" to 1½ " diameter.

3.2.8.9 Standard of Acceptance: Ecoflex

3.2.9 Manifolds (Commercial, Valved Copper)

3.2.9.1 For system compatibility, use 2-inch valved copper manifolds manufactured from Type L copper material, offered by the respective PEX tubing manufacturer. Valving shall include ball isolation valves and balancing valves

3.2.9.2 Install valved copper manifolds primarily for wall-hung or boxed applications.

3.2.9.3 Use manifolds with an isolation valve or a combination isolation and balancing valve on each outlet.

3.2.9.4 Use manifolds that support ⅝ inch or ¾ inch PEX tubing.

3.2.9.5 Ensure manifold end cap offers tapping for ¼ inch FNPT and ½ inch FNPT for vent and drain.
3.2.9.6 Install supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.

3.2.9.7 If the supply and return piping is in direct-return configuration, install and balance flow setters on the return leg of each manifold to the mains.

3.2.10 Fittings

3.2.10.1 For system compatibility, use fittings, connectors, wall sleeves and other accessories offered by the PEX tubing manufacturer, including connectors to metallic piping.

3.2.10.2 The fitting assembly must comply with ASTM F877 and CAN/CSA B137.5 requirements.

3.2.10.3 Fitting assembly manufactured from UNS C3600 series brass material.

3.2.10.4 The fitting assembly consists of a barbed insert, a compression ring and a compression nut. The barbed insert is manufactured with an o-ring to facilitate air pressure testing.

3.2.10.5 Fittings manufactured in accordance with ASTM F1960.

3.2.10.6 Fitting assembly manufactured from material listed in paragraph 5.1 of ASTM F1960.

3.2.10.7 The fitting assembly consists of a barbed adapter and an applicable sized PEX ring. The barbed insert may include an o-ring to facilitate pressure testing with air.

3.2.11 Manifold Chamber

3.2.11.1 Construction

- Pre-cast or poured in place concrete. Footprint and depth sized to avoid classification as “confined space”. Coordinate with Structural Division.

3.2.11.2 Access door:

- Material: Cover and frame are 1/4" (6.35mm) aluminum
- Cover: Smooth plate reinforced for 150 psf (732 kg/m2) live load. Cover designed with 1" (25.4mm) fillable pan for field installation of flooring material (specify flooring material including type, thickness, and weight).
Frame: Extruded aluminum frame with built in anchor flange around the perimeter.
Hinges: Continuous heavy-duty type 316 stainless steel hinge.
Latch: Type 316 stainless steel slam lock with fixed interior handle and removable exterior turn/lift handle. Latch release is protected by a flush, gasketed, removable screw plug.
Lift Assistance: Compression spring operators enclosed in telescopic tubes. Automatic hold-open arm with grip handle release.
Finish: Mill Finish aluminum with a bituminous coating applied to the exterior of the frame.
Hardware: Engineered composite compression spring tubes. Steel compression springs with electro coated acrylic finish. Type 316 Stainless steel hinges. All other hardware is zinc plated/chromate sealed.
Standard of acceptance: Bilco model TER, size 48”x72”.

3.3 PUMPS

3.3.1 Vertical In-Line Centrifugal Pumps

3.3.1.1 Applicable: primary loop flow larger than 200 gpm, all secondary loops

3.3.1.2 Furnish and install, as indicated on the plans and specifications, in-line split couple vertical centrifugal pumps. Capacity and power supply: as indicated on the equipment schedule.

3.3.1.3 Pump Casing - Cast Iron with 125 psig ANSI/PN16 flanges for working pressure below 175 psig (12 bar) at 150°F (65°C) and Ductile Iron with 250 psig ANSI/PN25 flanges for working pressures to 375 psig (25 bar) at 150°F (65°C). Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.

3.3.1.4 Impeller - Bronze, fully enclosed type. Dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.

3.3.1.5 Shaft - Provide Stainless Steel pump shaft.

3.3.1.6 Coupling - Rigid spacer type of high tensile aluminum alloy. Coupling to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.

3.3.1.7 Mechanical Seals - Shall be Stainless Steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary
seat. Provide 316 stainless steel gland plate. Provide factory installed flush line with manual vent.

3.3.1.8 All split coupled pumps shall be provided with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication.

3.3.1.9 Seal flush line accessories, if required to improve seal chamber cleanliness: Supply in the flush line to the mechanical seal a 50 micron cartridge filter and sight flow indicator, to suit the working pressure encountered.

3.3.1.10 Filters shall be changed, by the installing contractor, after system is flushed and on a regular basis until turned over to the Board.

3.3.1.11 Standard of Acceptance: Taco, Armstrong 4300 series, Grundfoss.

3.3.2 Suction Guides

3.3.2.1 Furnish and install on the suction of each pump a suction guide, with outlet flow stabilizing guide vanes, removable stainless steel strainer and fine mesh start-up strainer.

3.3.2.2 For 150 psig flanged pipe: Supply valve with Cast Iron body with 125 psig flanged ports.

3.3.2.3 For 300 psig flanged pipe: Supply valves with Ductile Iron body and 250 psig flanged ports.

3.3.2.4 Standard of Acceptance: Taco, Armstrong SG series, Taco, Grundfoss

3.3.3 Triple Duty Valves

3.3.3.1 The valve stem shall be stainless steel with flat surfaces provided for adjustment with open-end wrench.

3.3.3.2 PN25 ductile iron flanges with antirotation lugs and EPT gaskets.

3.3.3.3 For Welded Flange Piping: For 10 bar flanges: Valve body shall be Cast Iron with PN16 flanged ports. For 20 bar flanges: Valve body shall be Ductile Iron with PN25 flanged ports.

3.3.3.4 The valve shall be selected and installed in accordance with the manufacturer’s instructions and be suitable for the pressure and temperature specified.
3.3.3.5 Insulation

- Each triple-duty valve shall be furnished with a pre-formed removable PVC insulation jacket to meet ASTM D1784 Class 14253- C, MEA #7-87, ASTM-E-84 and ASTM136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less. There will be provided sufficient mineral fiberglass insulation to meet ASHRAE 90.1-1989 specifications in operating conditions with maximum Fluid Design Operating Temperature Range of 141°F-200°F (60°C-93°C) and Mean Rating Temperature of 125°F (52°C).

3.3.3.6 Standard of Acceptance: Taco, Armstrong, Grundfoss.

3.3.4 In-Line Circulator Pump

3.3.4.1 Applicable: primary loop flow per boiler smaller than 100 gpm

3.3.4.2 General:

- For size, flow and head, refer to the equipment schedules.

- Pump shall be BF (Bronze Fitted) construction, three-piece design featuring the Armstrong shaft and bearing module which shall fit all models S25 through S57 and H32 through H54. The shaft oil-lubricated bronze sleeve bearing. Pump to be equipped with a water-tight, long life, "ARMSEAL" mechanical seal and be suitable for 225°F, 125 psi

3.3.4.3 Standard of Acceptance: Taco, Armstrong, Grundfoss.

3.3.5 Circulator Pump Circuit Balancing Valve

3.3.5.1 Furnish and install downstream of each in-line circulator pump, a circuit balancing valves. Valves are to be of the ‘Y’ pattern, equal percentage globe-style and provide three functions: 1) Precise flow measurement, 2) Precision flow balancing, 3) Positive drip-tight shut-off.

3.3.5.2 Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve hand wheel. Valves shall have a minimum of five full 360° hand wheel turns. 90° ‘circuit-setter’ style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.

3.3.5.3 Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, ¼" threaded brass metering ports with check valves and
gasketted caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The hand wheel shall be high-strength resin.

3.3.6 Standard of Acceptance: Taco, Armstrong, Grundfoss.

3.4 TESTING, ADJUSTING AND BALANCING (TAB)

3.4.1 Coordinate with the mechanical Contractor the TAB activity such that it does take place before the insulation is installed on ductwork and piping.

3.4.2 In the absence of such coordination, the mechanical contractor shall be responsible for the repair to the ductwork and or piping insulation removed for TAB purposes, including the integrity of the vapor barrier material and the insulation jacket.

3.5 DIGITAL CONTROLS

3.5.1 System Hardware

3.5.1.1 The system architecture will be comprised of PCUs (Primary Control Units), PACs (Programmable Application Controllers), ASCs (Application Specific Controllers) and any required communications or interface components networked together to provide a system of connected controllers that operate as a single BAS for the entire project.

3.5.1.2 All required site database and graphics files shall reside on the Go Transit/Metrolinx central BAS server. The connection between the central server and the BAS controllers serving a specific building shall be through the WAN.

3.5.1.3 The building Staff shall be able to log into the local Workstation, access and review on a read-only basis the graphical user interface of the BAS showing the system layout and operational parameters.

3.5.1.4 The Go Transit/Metrolinx specialized trades shall be capable of accessing and modifying the BAS parameters and schedules using direct connectors at the control panels and portable computers (laptops, notebooks, etc).

3.5.1.5 Supply PCU’s, PAC’s and ASC’s as required to interface to all specified equipment.

3.5.1.6 Allow for a minimum of 25% spare program and trend memory capacity in each PCU and PAC.
3.5.1.7 For each specified BAS control point, the contractor shall supply the hardware point type (e.g. AI, AO, DI, DO) as indicated on the controls points list. The use of alternate hardware point types or the use of external interface cards or devices to simulate the function of a specified hardware point type is not acceptable. For example, the use of a DO point and an external PWM card to simulate the function of a physical AO point shall not be accepted.

3.5.2 Primary Control Units (PCU)

3.5.2.1 Use only Primary Control Units to directly control any major mechanical equipment. Major mechanical equipment includes air handling units, boiler plants, chiller plants, cooling towers, roof-top units and other critical equipment.

3.5.2.2 Each PCU shall contain a real time clock and sufficient memory to store the its own application database, operating parameters, user programs and trend data storage.

3.5.2.3 Battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours to eliminate operating data reload in case of power failure.

3.5.2.4 Each PCU output shall include a Hand/Off/Auto (HOA) selector switch for each analog and digital output.

3.5.2.5 Each PCU shall have a minimum of 10% spare capacity for each type of input and output channels and 10%.

3.5.3 Programmable Application Controllers (PAC)

3.5.3.1 Programmable Application Controllers (PAC) are fully programmable controllers used for controlling distributed equipment including, but not limited to pumps, exhaust fans, VAV boxes, heat pumps, force flow units and unit ventilators.

3.5.3.2 PACs shall not be used for controlling major mechanical equipment as described above.

3.5.3.3 Each PAC shall contain a real time clock and sufficient RAM to store its own application database, operating parameters, user programs and trend data storage.
3.5.3.4 Battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours to eliminate operating data reload in case of power failure.

3.5.4 System Software

3.5.4.1 BAS Workstation Software

- Site licenses are not required.

3.5.4.2 Trend Data

- Provide trend logs for all hardware inputs and outputs.
- All trends should be accessible via the graphical interface.
- Trends should contain all related variables of a control loop (i.e. setpoint, measured variable and control output) and have the ability to be plotted simultaneously on the same graph.
- Field Devices individual trends should provide an appropriate “snapshot” of the variable. Slow reacting variables such as space temperatures should be sampled every 30 - 60 minutes while other variables such as mixed air or boiler water temperatures should be sampled every 5 to 10 minutes.
- Provide the maximum number of trend samples within the controller while maintaining the requirement for spare memory capability.
- The primary input sensor for all control loops must physically be wired to the same panel containing the control loop output (e.g. boiler water temperature and burner control output).
- Trend data storage must be in the same panel as the hardware or logical points being trended.

3.5.5 User Access

3.5.5.1 Provide Go Transit-standard user IDs and passwords for operations, maintenance and engineering staff.
3.6 Alarms

3.6.1.1 Alarms shall be assigned the following categories:

- Maintenance Alarms
- Mismatch of equipment control and status for more than 30 minutes
- Any other miscellaneous alarm not specifically noted herein

3.6.1.2 Alarms shall not require any acknowledgment before automatic reset by the system.

3.6.1.3 An alarm notification shall not be issued when an alarm condition returns to normal.

3.6.1.4 The Contractor shall provide additional alarms as directed by the Consultant and specified in this section and customize the alarms to the operating characteristics of the specific systems being controlled.

3.6.2 Bas Dynamic Graphics

3.6.2.1 Provide customized, site specific dynamic graphics to meet the requirements of the Consultant and/or Go Transit

3.7 Sensors and Devices

3.7.1 Snow Slab Sensor

3.7.1.1 The snow / ice sensor and socket are used with the main controller to automatically detect snow or ice on a driveway or walkway. The snow / ice sensor socket must be installed directly in the snow melt slab, halfway between the heating elements or pipes.

3.7.1.2 Sensor weight - 4.4 lb (2000 g), silicon brass. 65 ft (20 m) jacketed cable

3.7.1.3 Socket weight - 1.8 lb (830 g), silicon brass

3.7.1.4 Dimensions (sensor) – 1¾" H x 3-1/8" W x 3-1/8" D (45 x 80 x 80 mm)

3.7.1.5 Dimensions (socket) - 3¾" H x 3½" W x 3½" D (96 x 89 x 89 mm)

3.7.1.6 Operating range - minus 60 to plus 175°F (-50 to 80°C)

3.7.1.7 Sensor - NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C), β=3892
3.7.1.8 Standard of Acceptance: Tekmar type 094 in socket type

3.7.2 In-Slab Sensor

3.7.2.1 Slab sensor has a PVC plastic sleeve which is designed for use in soils or concrete. The sensor is supplied with 40ft (12m) of 2 conductor cable.

3.7.2.2 Packaged Weight - 0.7 lb. (320 g), PVC sleeve. 40' (12 m) jacketed wire

3.7.2.3 Dimensions - ½" OD x 2" (13 OD x 51 mm)

3.7.2.4 Operating range – minus 60 to 140°F (-50 to 60°C)
3.7.2.5 Sensor - NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C), β=3892

3.7.2.6 Standard of Acceptance: Tekmar 073

3.7.3 Outdoor Air Temperature Sensors

3.7.3.1 Provide outdoor air temperature sensors with the following minimum characteristics:

- Each sensor shall be a 6”, 10K thermistor probe
- Minimum two sensors shall be installed for each site.
- Both sensors shall be mounted inside a heavy-duty (blow-proof) solar shield.
- Provide a heavy-duty, metal, wire guard.

3.7.3.2 Standard of Acceptance: Enercorp TS-O-T-10K, Honeywell, Johnson Controls

3.7.4 Immersion Temperature Sensors

3.7.4.1 Use immersion temperature sensors with thermwells for all applications where a temperature of a fluid in a pipe is being sensed.

3.7.4.2 Provide well-mounted water temperature sensors with the following minimum characteristics:

- The sensors shall be 10k ohm thermistor encapsulated in a 6mm OD, 50m long probe, with screw fitting for insertion into a standard thermowell.
- Operating range -10 to +100 degrees C.
- End-to-end accuracy +/- 0.3 °C over the entire operating range.
- The sensors shall be complete with brass thermowell. Provide a stainless steel thermowell where exposed to corrosive liquids.
- Use conductive gel when mounting the sensor in the thermowell.
The sensors to be mounted on insulated piping shall be installed clear of the insulation.

3.7.4.3 Standard of Acceptance: Enercorp TS-P-4-T-10K, Honeywell, Johnson Controls

3.7.5 Current Sensors (Analog)

3.7.5.1 Current sensors (CT) shall be used for status monitoring of all motor-driven equipment, where specified.

3.7.5.2 Technical Performance – Output should be only 4-20mA only. Voltage output will not be accepted. End-to-end accuracy +/- 1% of full scale at each range.

3.7.5.3 The current sensors shall be mounted inside the starter cabinets whenever possible. If this is not possible due to space limitation, provide an enclosure to house the sensor.

3.7.5.4 Standard of Acceptance: Enercorp SA200, Honeywell, Johnson Controls

3.7.6 CO Monitoring Sensor

3.7.6.1 Two-wire transmitter providing continuous monitoring for carbon monoxide in ambient air (0-500 ppm). Linear 4-20 mA output with two factory-set alarm levels and two alarm outputs.

3.7.6.2 Cover Aluminum cover mounting plate fits standard single outlet electrical box

3.7.6.3 Power Supply 50 mA; Supply Voltage 10 to 28 Vdc; (24 Vdc nominal) Power Consumption Maximum: 24 mA @ 24 Vdc. Nominal: 4 mA @ 24 Vdc

3.7.6.4 Temperature Range 0 to 50°C (32 to 122°F) Humidity 15 to 90% non-condensing

3.7.6.5 Sensor Zero-maintenance electrochemical

3.7.6.6 Self-test fail: 2 mA signal; Sensor expired: 2 mA signal; Over range gas alarm: 24 mA signal (maximum). Power off: 0 mA signal

3.7.6.7 LED Indicator Advice Power on: On. No power: Off

3.7.6.8 Self-test fail: fast flash (1 flash every 0.5 seconds). Life ending warning: slow flash (1 flash every 2 seconds) - Provides one month warning prior to expiry date. Operational Life Ended: Off

3.7.6.9 Self-test On activation (auto) and daily (auto)
3.7.6.10 Warranty Two (2) year (3 year operational life)

3.7.6.11 Ratings and Certifications

- Conforms to n Ordinary locations International Electrical Code: IEC No. 61010
- EMI/RFI Complies with EMC Directive 89/336/EEC

3.7.6.12 Standard of Acceptance: Vulcain/Honeywell Toxypoint Series

3.7.7 Status Relays (Solid State)

3.7.7.1 The status relays shall be mounted inside newly provided enclosures mounted near the respective equipment starter cabinets.

3.7.7.2 Standard of Acceptance: Omron G7L-1A, Honeywell, Johnson Controls

3.7.8 Automatic Control Valves

3.7.8.1 Automatic control valves shall be supplied by the Controls Contractor and installed by the Mechanical Contractor.

3.7.8.2 Automatic control valves, unless otherwise specified, shall be globe type valves. Valves and actuators shall be ordered as one factory-assembled and tested unit.

3.7.8.3 Submit to the Consultant for review, a valve schedule containing the following information for each valve:

- Valve type and size
- Connection type
- Line size
- Valve manufacturer and model number
- Valve flow coefficient
- Design flow
- Pressure drop across valve
- Maximum close-off pressure
- Actuator manufacturer and model number
- Actuator maximum torque

3.7.8.4 Valves 2” (50mm) and smaller shall be constructed of bronze. Valves 2½” (65mm) and larger shall have iron bodies and bronze mountings.

3.7.8.5 All control valves shall have stainless steel stems.
3.7.8.6 The bronze in bodies and bonnets of all bronze valves shall conform to ASTM B62 for valves rated up to 150psig (1035 Kpa) working pressure and to ASTM B61 for valves rated at 200 psig (1380 Kpa) working pressure.

3.7.8.7 The bodies and bonnets of iron body valves shall conform to ASTM A126, Class B.

3.7.8.8 Control valve discs and seats shall be of bronze for 100°C or less fluid temperature and of stainless steel for fluid temperatures above 100 °C.

3.7.8.9 The control valves shall have tight shut-off. Flat disk valves are not acceptable.

3.7.8.10 Control valves 2” (50mm) and smaller shall be complete with screwed ends type, except for bronze valves installed in soldered copper piping which shall be complete with soldering ends. Control valves larger than 2” (50mm) shall be complete with flanged end type and proper flanged adapters to copper shall be provided where flanged valves are installed in copper piping.

3.7.8.11 The water control valves shall be sized for a pressure drop of 6 ft. water column or as indicated on mechanical drawings.

3.7.8.12 Each automatic control valve must provide the design output and flow rates at pressure drops compatible with equipment selected.

3.7.8.13 Each automatic control valve must be suitable for the particular system working pressure.

3.7.8.14 Each automatic control valve shall be fitted with a position indicator.

3.7.8.15 All the same type control valves shall be the products of a single manufacturer and have the manufacturer’s name, pressure rating and size clearly marked on the outside of the body.

3.7.8.16 Unless otherwise indicated, control valves for proportional operation shall have equal percentage characteristics, while the control valves for open/shut two-position operation shall have straight line flow characteristics.

3.7.8.17 Standard of Acceptance:

- Siemens
- Danfoss
- Honeywell
3.7.9 **Automatic Control Valve Actuators**

3.7.9.1 Each automatic control valve shall be fitted with a “fail-safe” operator capable of tight shut-off against the differential imposed by the system.

3.7.9.2 Operators for valves in electric-electronic control systems shall be single phase AC, 24V electric motor operators.

3.7.9.3 Valve actuators on valves 3” diameter and larger shall be provided with a manual position override.

3.7.9.4 Valve actuators shall accept a 0-10VDC or 4-20mA control signal for all proportional applications.

3.7.9.5 Floating point control of valves is not acceptable under any circumstances.

3.7.10 **Local Service Ports**

3.7.10.1 Every DDC panel shall be provided with a local network access port to connect to laptop computer. A user connected to the local access port shall have the same level of system access and functionality as being connected to the networked Go Transit Workstation.

3.7.10.2 Where BAS points (4 or more) are located in a mechanical room that does not have a local BAS panel installed, a remote network access port shall be provided. The access port shall be installed in a hinged metal enclosure with key-lock set and laminoid ID label.

3.7.11 **LAN Cabling**

3.7.11.1 All LAN cabling shall be Category V as defined by EIA/TIA 568A. The contractor shall test all cabling to verify that 100Mb bandwidth is supported. See commissioning requirements.

3.7.11.2 Cabling shall be 4 pair, 100 ohm UTP, #24 AWG solid copper conductor PVC insulated, with blue or grey colour coded jacket. FT6 rated cable shall be used unless otherwise required to meet building codes or by-laws.

3.7.11.3 Data outlets shall be RJ45, 8 pin connectors, with 50 microns of hard gold over nickel, minimum durability of 750 mating cycles and contact pressure of 100 grams per contact. Transmission characteristics shall meet TSB-40 Category V.
3.7.11.4 Provide one RJ45 data outlet adjacent to each device to be terminated (e.g. workstation PC, DDC panel, hub, etc.) Use a flexible patch cable to connect from the data outlet to the end device.

3.7.11.5 Provide protection from EMI sources in accordance with CSA-T530 article 4

3.7.11.6 The contractor shall test all cabling to verify conformance with TIA /EIA TSB-67 - Basic Link Test using a Level 2, bi-directional tester. See commissioning requirements.

3.7.11.7 Where there are more than 2-90 degree in a conduit run, provide a pull box between sections so that there are two bends or less in any one section.

3.7.11.8 Where a conduit run requires a reverse bend, between 100 degrees and 180 degrees, insert a pull box at each bend having an angle from 100 degrees to 180 degrees.

3.7.11.9 Ream all conduit ends and install insulated bushings on each end. Terminate all conduits that protrude through the structural floor 2" above the concrete base. Do not use a pull box in lieu of a conduit bend. Align conduits that enter a pull box from opposite ends with each other.

PART 4 EXECUTION

4.1 BOILERS

4.1.1 Installation

4.1.1.1 Install boilers level and plumb on concrete pad. For vibration isolation, refer to section 15241.

4.1.1.2 Arrange piping as to provide adequate clearance for service and operation. In particular, ensure that the gas train assembly does not interfere with the clearances required for boiler and burner maintenance work. Pipe safety relief valves and drain valves to floor drain. Install thermometers and pressure gauges on supply and return piping no higher than 1800 mm above floor. Install temperature and pressure sensors in accordance with the manufacturer’s recommendations, to ensure correct readings.

4.1.1.3 Install relief valve sized to suit boiler input and located upstream of any shut-off valve. Conform to manufacturer’s installation instructions and piping schematic on drawings. Extend each gas pressure relief (full size) through roof and terminate with gooseneck and screen.
4.1.1.4 Upon notification of completion of the installation, boiler manufacturer shall furnish the services of a field technician, to:

- Start-up and adjust the boiler
- Start-up and adjust the burner
- Provide combustion tests over the operating range.
- Issue report to the Consultant indicating system acceptance as installed.

4.1.1.5 The manufacturer’s qualified representatives shall inspect the venting system and shall supply/install draft control devices, if so required by the local configuration of the building. There will be no additional charge to the Owner for this operation.

4.1.1.6 Contractor shall provide all wiring, disconnects, relays and other devices as required to provide power to the burners and boiler controls.

4.2 HEPEX SNOW MELTING TUBING

4.2.1 Manufacturer’s Instructions

4.2.1.1 Comply with manufacturer’s product data, including product technical bulletins, installation instructions and design drawings.

4.2.2 Insulation

4.2.2.1 Use a 2” (50 mm) rigid layer of Styrofoam insulation under the tubing.

4.2.3 Installer’s Experience

4.2.3.1 The installing contractor shall have a min. of 10 years of demonstrated experience on projects of similar size and complexity in Ontario

4.2.4 Examination

4.2.4.1 Verify that site conditions are acceptable for installation of the snow and ice melt system.

4.2.4.2 Do not proceed with installation of the snow and ice melt system until unacceptable conditions are corrected.
4.2.5 Installation

4.2.5.1 Slab-on-grade Construction with Edge and Under-slab Insulation

- When using high-density foam insulation board, install the tubing by stapling the tubing to the insulation board with Uponor Foam Staples.

- The under-slab insulation shall be rigid 2" polystyrene suitable for underground applications.

- Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.

- The submitted snow-melt design shall specify the tubing on-center distance(s) and loop lengths, based on output and tubing diameter. On-center distances will not exceed 12 inches (305mm).

- On a 24” wide band along the platform edge, the piping density shall be increased to the maximum allowed by the manufacturer (6” on centre) regardless of the size of the tubing.

- Do not install tubing closer than 6 inches (152mm) from the edge of the heated slab.

- Install the tubing at a consistent depth below the surface elevation as determined by the project engineer. Tubing installation will ensure sufficient clearance for all control joint cuts.

- In areas where tubing must cross metal expansion joints that occur in the concrete, the tubing shall pass below the metal expansion joints.

- Fibrous expansion joints may be penetrated following the PEX tubing manufacturer’s and structural engineer’s recommendation.

- Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90 degree bend.

4.2.5.2 Pavers Over a Compacted Bed Construction with Edge and Under-slab Insulation

- When using high-density foam insulation board, install the tubing by stapling the tubing to the insulation board with manufacturer-supplied staples.
The under-slab insulation shall be rigid 2” polystyrene suitable for underground applications.

Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.

The submitted snow-melt design shall specify the tubing on-center distance(s) and loop lengths, based on output and tubing diameter. On-center distances will not exceed 9 inches (229mm).

On a 24” wide band along the platform edge, the piping density shall be increased to the maximum allowed by the manufacturer (6” on centre) regardless of the size of the tubing.

Do not install tubing closer than 6 inches (152mm) from the edge of the heated slab.

Bedding material for all tubing shall be layer min. 6” deep of compacted #8 crushed limestone and screenings (3/8” diam). The fill over the PEX tubing must be void of any sharp material. The pavers are then installed over the compacted soil bed.

Backfilling of all pipe shall be well compacted by means of jetting or other approved methods to eliminate settling. Any completed areas that show settlement shall be promptly re-backfilled with compacted clean earth.

Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90 degree bend.

4.2.5.3 Asphalt Construction with Edge and Under-slab Insulation

When using high-density foam insulation board, install the tubing by stapling the tubing to the insulation board with Uponor Foam Staples.

The under-slab insulation shall be rigid 2” polystyrene suitable for underground applications.

Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.

The submitted snow-melt design shall specify the tubing on-center distance(s) and loop lengths, based on output and tubing diameter. On-center distances will not exceed 9 inches (229mm).
- On a 24” wide band along the platform edge, the piping density shall be increased to the maximum allowed by the manufacturer (6” on centre) regardless of the size of the tubing.

- Do not install tubing closer than 6 inches (152mm) from the edge of the heated slab.

- Bedding material for all tubing shall be layer min. 6” deep of compacted #8 crushed limestone and screenings (3/8” diam). The fill over the PEX tubing must be void of any sharp material. The pavers are then installed over the compacted soil bed.

- Backfilling of all pipe shall be well compacted by means of jetting or other approved methods to eliminate settling. Any completed areas that show settlement shall be promptly re-backfilled with compacted clean earth.

- Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90 degree bend.

4.2.5.4 Poured-in-place Stair Construction

- Fasten the tubing to flat wire mesh or reinforcing bar in accordance with the PEX tubing manufacturer’s installation recommendations.

- The submitted snow-melt design specifies the tubing on-center distance(s) and loop lengths. On-center distances will not exceed 9 inches (229mm).

- Install the tubing parallel to the step tread.

- Install the supply side of the loop along the step's edge. Install the tubing will be within 3 inches (76mm) of the step's edge.

- The under-slab insulation shall be 2” polystyrene suitable for underground applications.

- Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.

- Install the tubing at a consistent depth below the surface elevation as determined by the consultant.

- Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90 degree bend.
4.2.5.5 Heating Agent Distribution Piping

- Piping shall be installed in a schedule 40 PVC pipe sleeve; the sleeve size shall be two diameter sizes larger than the combined diameter of the distribution piping plus insulation plus jacket.

- Maintain min. 4” horizontal distance between the PVC sleeves.

- Coordinate with the site services discipline the depth of the sleeves and the back-filling material, depending on the nature of the surface above (landscape, pedestrian traffic, vehicular traffic, train right of way, etc).

- Respect the minimum bending radius recommended by the manufacturer.

4.2.6 Glycol/Water Solution

4.2.6.1 The heating fluid shall be premixed glycol/water solutions. PEX tubing manufacturer allows site-mixed solutions if mixed to the proper concentration before entering the system.

4.2.6.2 Mix the glycol/water solution to proper concentration levels to protect the system freezing during operation shutdown.

4.2.6.3 System circulators must operate continuously for a minimum of 30 days after the system is filled to ensure the glycol and water does not separate in a static system.

4.2.6.4 Do not use ethylene glycol due to toxicity issues. Instead, use of inhibited propylene glycol. Also, refer to the boiler manufacturer’s recommendations.

4.2.7 Field Quality Control

4.2.7.1 Site Tests

- To ensure system integrity, pressure test the system before covering tubing in concrete or when other trades are working in the vicinity of the tubing.

- Test all electrical controls in accordance with respective installation manuals.
4.2.8 Adjusting

4.2.8.1 Balancing Across the Manifold

- Balance all loops across each manifold for equal flow resistance based on actual loop lengths and total manifold flow.

- Balancing is unnecessary when all loop lengths across the manifold are within 3 percent of each other in length. Install the supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.

- Balancing between manifolds is accomplished with a flow control device installed on the return piping leg from each manifold when direct return piping is used for the supply and return mains.

- Adjust all boiler and system controls after the system has stabilized to ensure proper operation in accordance with the system design.

4.2.9 Cleaning

4.2.9.1 Remove temporary coverings and protection of adjacent work areas.

4.2.9.2 Repair or replace damaged installed products.

4.2.9.3 Clean installed products in accordance with manufacturer’s instructions prior to owner’s acceptance.

4.2.9.4 Remove construction debris from project site and legally dispose of debris.

4.2.10 Demonstration

4.2.10.1 Demonstrate operation of hydronic snow and ice melting system to owner’s personnel.

4.2.10.2 Advise the owner’s representative about the type and concentration of glycol/water solution used in the hydronic snow and ice melting system.

4.2.10.3 The owner monitors the solution effectiveness through an established maintenance program as outlined by the glycol manufacturer.

4.2.11 Protection

4.2.11.1 Protect installed work from damage caused by subsequent construction activity.
4.3 **PUMPS**

4.3.1 Install with bearing lubrication points accessible. Check rotation.

4.3.2 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to drawings and manufacturer's installation instructions for details.

4.3.3 Provide vibration isolation between the pumps and pipes, and between the pumps and the concrete curbs. Refer to section 15241.

4.3.4 Pipe drain tapping to floor drain.

4.3.5 Install volute venting pet cock in accessible location.

4.3.6 Change cartridge filter on regular basis prior to, and at turn over to owner.

4.3.7 Provide strainers, isolating valves, balancing valves and check valves as indicated on the drawings.

4.3.8 Install a suction guide upstream of each vertical in-line pump. The mechanical contractor shall inspect the strainer prior to activating the pump and, further, shall remove the fine mesh start-up strainer after a short running period. (24 hours maximum). Space shall provided for removal of the strainer and connection of a blow-down valve.

4.3.9 Install a triple duty valve on the discharge of each vertical in-line pump.

4.3.10 Contractor to provide and install one pressure gauge, piped to pump suction, pump discharge and strainer inlet. Pressure gauge tappings with necessary isolating valves to enable differential pressure reading across pump and strainer to be taken.

4.3.11 Contractor shall cover motor during construction and have area clean of construction debris before starting the motor.

4.3.12 Contractor to follow the manufacturer's instructions for start-up and venting of mechanical seal.

4.3.13 If pump is used during temporary heating or flushing of system, contractor shall be responsible for changing mechanical seal or replacing motor bearings if so instructed by the board representative.

4.3.14 The pump manufacturer shall coordinate with the hydronic balancer to balance the system to the required flows.
4.3.15  Provide drip pan and piped to nearest drain for each pump. Drip pan shall be sized to suit pump dimensions.

4.4  TESTING, ADJUSTING AND BALANCING (TAB)

4.4.1  General

4.4.1.1  Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

4.4.2  Systems Inspection Report

4.4.2.1  Inspect equipment and installation for conformance with design.

4.4.2.2  The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

4.4.2.3  Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Consultant.

4.4.2.4  Reports: Follow check list format developed by AABC or SMACNA, supplemented by narrative comments

4.4.3  Tab Report

4.4.3.1  Format to be in accordance with referenced standard listed above, but using design drawing units.

4.4.3.2  Produce "as-built" full system schematics. Use as-built drawings for reference.

4.4.3.3  Submit 1 copy of preliminary TAB reports, each in "D" ring binders, complete with index tabs for verification and approval of Consultant.

4.4.3.4  Submit copies of final TAB reports after approval by the Consultant, to be incorporated into the Maintenance and Operations Manual, as indicated in section 15010.

4.4.4  Procedures

4.4.4.1  Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified.
4.4.4.2 Start final TAB only when building is essentially completed, including: normal operation of mechanical systems affecting TAB.

4.4.4.3 General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

4.4.5 Water Balance And Equipment Test:

4.4.5.1 Include all circulating pumps, heat exchangers, boilers, coils, chillers, coolers and condensers, as applicable to this project.

4.4.5.2 Adjust flow rates for equipment to the values indicated on the drawings and schedules. Set balancing valves and circuit setters to the values on indicated on the equipment schedules.

4.4.5.3 Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for heat exchangers. Include entering and leaving air temperatures for all equipment (boilers, manifolds, mixing valves, etc).

4.4.6 Verification:

4.4.6.1 Reported measurements shall be subject to verification by Consultant. Provide instrumentation and manpower to verify results of up to 30 % of all reported measurements. Number and location of verified measurements to be at discretion of Consultant.

4.4.6.2 Bear costs to repeat TAB, as required, to satisfaction of Consultant.

4.4.7 Marking Of Settings

4.4.7.1 Following approval of TAB final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Consultant.
4.5 **DIGITAL CONTROLS**

4.5.1 **Sequence Of Operation**

4.5.1.1 The heating plant shall serve both the snow melting system and the in-floor radiant heating system. It is possible that one of the systems may be operational while the other remains idle. These specifications refer to the sequence of operation for the snow-melting system; this sequence does not preclude the energizing of the boiler plant for comfort heating purposes before the snow melting secondary loop is energized.

4.5.1.2 These specifications shall be read in conjunction with the GO Transit/Metrolinx specifications for in-floor radiant heating.

4.5.1.3 The heating plant shall be enabled/disabled by the BAS based on outdoor temperature \( T_1 \).

4.5.1.4 The snow melting system shall be enabled/disabled by the BAS based on outdoor air temperature \( T_2 \).

4.5.1.5 The default relationship between the two outdoor temperatures shall be \( T_1 > T_2 \). The gradient shall be adjustable by the Owner.

4.5.1.6 With the system enabled, the lead primary boiler pump shall start, while the lag pump shall be energized and in stand-by mode. The lead/lag status of the primary pumps shall alternate at 168 hrs. intervals (adjustable).

4.5.1.7 Upon proof of flow in the primary loop, the lead boiler shall start at minimum firing rate, while the lag boiler shall be energized and in stand-by mode. The lead/lag status of the boilers shall alternate at 168 hrs. intervals (adjustable).

4.5.1.8 After the lead boiler started, its firing rate shall modulate as required to maintain the primary loop return temperature at 125°F (51°C), and subject to a maximum primary loop supply temperature of 150°F (66°C). All setpoints adjustable.

4.5.1.9 If the lead boiler fires at max. rate for 10 minutes and can not maintain the primary loop return temperature setpoint, the lag boiler shall start at minimum firing rate; its burner shall ramp as required to maintain the primary loop return setpoint, subject to the same maximum primary loop supply temperature of 150°F (66°C). Where applicable (individual boiler circulators), the energizing of the lag boiler shall be preceded by the start-up of the lag boiler circulator (primary flows of less than 200 gpm).
4.5.1.10 With the snow melting system enabled, the lead secondary snow melting loop pump shall start, while the lag pump shall be energized and in stand-by mode. The lead/lag status of the secondary snow melting loop pumps shall alternate at 168 hrs. intervals (adjustable).

4.5.1.11 The four-way mixing valve shall modulate as required to maintain the snow-melting slab temperature at the following temperatures:

- \(+32^\circ F (0^\circ C)\) if no snow or ice is detected on the surface of the slab by the respective sensor
- \(+40^\circ F (+4^\circ C)\) if snow or ice is detected on the surface of the slab.

4.5.1.12 Additional settings for the operation of the 4-way mixing valve:

- Maintain the minimum primary loop return temperature of 125\(^\circ\)F (51\(^\circ\)C)
- Maintain the maximum temperature differential in the snow melting loop of 25\(^\circ\)F (14\(^\circ\)C) to prevent slab thermal shock.

4.5.1.13 The system shall generate alarms in case of:

- Any pump failure (while automatically enabling the stand-by pump).
- Any boiler failure (while automatically enabling the stand-by boiler).
- Primary loop temperatures +/-10\(^\circ\)F (6\(^\circ\)C) departure from the setpoint.
- Slab temperature +/-5\(^\circ\)F (3\(^\circ\)C) departure from the setpoint.

4.5.2 Installation of Snow Sensor

4.5.2.1 The installation of the snow sensor shall conform to the detail attached to these specifications (S-1).

4.5.2.2 The contractor shall be responsible for the fabrication of the steel frame required to install the sensor at the prescribed elevation and maintain its position during the concrete pour.

4.5.2.3 The 13-point installation procedure described on the detail drawing shall be followed accurately; at the conclusion of the installation work, a report shall be issued by the Contractor confirming that all installation steps have been followed and the installation of the sensor is in conformance with the detail.

4.5.2.4 Installation of all wiring and tubing in the area of the sensor shall be as indicated on the detail.
4.5.3 Installation Of Temperature Sensors In Piping

4.5.3.1 The Controls Contractor shall supervise and direct the Mechanical Contractor to ensure that thermowells are installed as described herein.

4.5.3.2 For each immersion sensor, provide a compatible thermowell to the Mechanical Contractor for installation. Provide stainless steel thermowells where installed in piping carrying corrosive or chemically reactive fluids.

4.5.3.3 Install thermowells in piping such that the bottom of the well does not make contact with the pipe. Install the well at a 90 degree elbow or tee where the pipe diameter is less than the well length.

4.6 Installation Of Automatic Control Valves And Actuators.

4.6.1.1 The Mechanical Contractor, unless specified otherwise.

4.6.1.2 Each control valve shall be equipped with its own actuator.

4.6.1.3 The Controls Contractor shall ensure that each control valve assembly is properly connected and installed.

4.6.1.4 The Controls Contractor shall test, adjust and verify the operation of each control valve to ensure that it is properly functioning, as required and left in safe working order.

4.6.2 Installation Of Outdoor Air Temperature Sensors

4.6.2.1 The outdoor air sensors shall be mounted so that the ventilation slots on the solar shields are facing downward (when mounted horizontally) or towards the wall (when mounted vertically).

4.6.2.2 Mount the sensors on the north-facing side of the building away from direct sunlight.

4.6.2.3 Mount the sensors in an easily serviceable location.

4.6.2.4 Ensure that the sensors are located away from building exhaust air or equipment air flows.

4.6.3 Cutting And Patching

4.6.3.1 All cutting, patching, painting and making good for the installation of the BAS work shall be done by the BAS Contractor. All cutting shall be performed in a neat and true fashion, with proper tools and equipment.
4.6.4 Power Sources And Wiring Methods

4.6.4.1 All wiring shall be installed in EMT conduit unless specified otherwise. Exposed wiring in finished areas shall be installed in wiremold.

4.6.4.2 Wiring from DDC controllers to sensors and actuators and control system network and low voltage wiring running in accessible ceilings may be installed using LVT cable. Where the ceiling is used as a return air plenum, plenum rated cable shall be used in lieu of LVT cable.

4.6.4.3 Install EMT and cable at right angles to building lines, securely fastened, and in accordance with current electrical codes and standards.

4.6.4.4 Power and control wiring shall be copper conductor (RW90). For power wiring, provide #12 AWG (minimum) with a 3% maximum voltage drop in accordance with CEC requirements. Control wiring shall be a minimum of #14 AWG, unless otherwise specified.

4.6.4.5 The wires smaller than 18 gauge shall not be used and will not be accepted on the project except for: wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.

4.6.4.6 The wiring from panels to devices shall be installed without splices. The use of crimp connectors is not allowed when connecting field wiring to sensor or device leads. The use of wire nuts is acceptable in this application.

4.6.4.7 Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently switched off. Only dedicated circuit(s) shall power the control system. Provide additional breakers or electrical panels as required.

4.6.4.8 Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line-side breakers/fuses for each transformer.

4.6.4.9 All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.

4.6.4.10 A dedicated power circuit may be used to power DDC panels and equipment within the same or adjoining mechanical rooms. The use of one power circuit to power DDC panels distributed throughout the building is not acceptable.
4.6.4.11 The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, rooftop unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status.

4.6.4.12 Provide all required code gauge boxes, connectors and other wiring accessories.

4.6.4.13 For all DC wiring, positive conductors shall be WHITE or RED in colour while negative conductors shall be BLACK in colour.

4.6.5 Electrical Wiring And Accessories

4.6.5.1 Install all electrical materials and equipment conform to Canadian Electrical Code as amended to date and as specified below.

4.6.5.2 Provide conduit, electrical wiring and fittings from load side of starters and/or disconnects to motor or electrical connected item, including the connections to all mechanical equipment.

4.6.5.3 Provide control wiring, conduit and relays to interlock starters and connect safety and operating controls as required.

4.6.5.4 Wire final 12 in to 18 in of motor connections with flexible liquid tight conduit, with insulated throat connectors.

4.6.5.5 Use thin wall conduit up to and including 1 ¼ in size for wiring in ceiling, furred spaces and where not exposed to mechanical injury. Use rigid galvanized steel conduit for exposed wiring and for conduit 1 ½ in size and larger.

4.6.5.6 Provide branch circuit wiring and an outlet for each motorized damper control.

4.6.5.7 Conduit shall be in accordance with the following CSA standards:

- C22.2 No.813 - 1976 - Electric Metallic Tubing
- C22.2 No.56 - 1977 - Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit
- C22.2 No.136 - 1966 - Rigid PVC Conduit

4.6.5.8 Install all wiring in conduit, unless otherwise specified.

4.6.5.9 Conduit accessories, condulets and fittings shall conform to C.S.A. Standard C22.2 No.18 - M1987.
4.6.5.10 Use thin wall conduit for branch circuit and signal wiring in ceiling, furred spaces and where not exposed to mechanical injury.

4.6.5.11 Conduit shall be of sufficient size to permit easy removal of conductors at any time. Do not bend conduit over sharp objects. Do not use bends and fittings together.

4.6.5.12 All conduit connections made to enclosures housing electrical devices (e.g. DDC panels, transformers, etc.) shall be made on the sides or bottom end of the enclosure. No openings of any kind shall be made to the top side of such enclosures.

4.6.6 Equipment Enclosures And Locations

4.6.6.1 Provide new enclosures for all field equipment (e.g. DDC panels, transducers, relays, etc.). Enclosures shall be equipped with a hinged door and latch. Provide a Go Transit standard key/lock set for each enclosure.

4.6.6.2 Mount all enclosures in serviceable areas of mechanical rooms, storage rooms or janitor closets. Obtain written approval of the Consultant prior to mounting any enclosure in ceiling spaces or more than 5'-6" above the finished floor.

4.6.6.3 All transformers and power supplies for control equipment shall be installed in new dedicated metal cabinets with hinged, lockable covers located in the proximity of their dedicated controller cabinets.

4.6.6.4 Include within a DDC panel enclosure one 120 VAC duplex receptacle for portable PC power, if the controller cabinet is located further than 5'-0" from the nearest wall receptacle.

4.6.6.5 Ensure that enclosures are sized to allow for ease of servicing of all equipment contained within. Enclosures containing DDC panels shall be sized to allow for the installation of the maximum allowable number of expansion panels/boards. Do not mount other equipment in a manner that may interfere with the future installation of expansion panels/boards.

4.6.6.6 For enclosures containing pneumatic transducers or devices, provide one pressure gauge (1-1/2" dial, 0-30psi) for the main air line supply.

4.6.7 Identification And Labeling Of Control Equipment

4.6.7.1 All panels must have a laminoid tag (min. 3"x1") affixed to the front face indicating panel designation and function (i.e. “BAS Panel 1” or “Relay Panel 3”).
4.6.7.2 All field sensors or devices must have a laminoid tag (min. 3”x1”) attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. AHU1_MAT, 2.IP4). Tags must be secured by screws where mounted outside of the building, in un-heated spaces, in high humidity areas or where subject to vibration.

4.6.7.3 All devices within a field enclosure shall be identified via a label or tag.

4.6.7.4 All BAS panel power sources must be identified by a label (min. 3”x1”) indicating the source power panel designation and circuit number (i.e. “120vac fed from LP-2A cct #1). 

4.6.7.5 All field control equipment panels fed from more than one power source must have a warning label on the front cover.

4.6.7.6 All wires shall be identified with the hardware address with a band-type self-adhesive strips or clip-on plastic wire markers at both ends.

4.6.7.7 All rotating equipment controlled by the BAS shall have a tag or label affixed indicating that the equipment may start without warning.

4.6.7.8 All BAS panels will be supplied with a point’s list sheet (within a plastic sleeve) attached to the inside door.

4.6.7.9 The points list shall identify the following for each point:

- Panel number.
- Panel location.
- Hardware address.
- Software name.
- Point description.
- Field device type.
- Point type (i.e. AI or DO).
- Device fail position.
- Device manufacturer.
- Model number or reference.
- Wire tag reference.

4.6.7.10 Provide laminated wiring diagrams for all field mounted relay enclosures. Securely attach to the inside door. Identify power panels and circuit numbers of the equipment being controlled.
4.6.7.11 Provide laminated wiring diagrams or modify existing equipment wiring diagrams wherever the BAS interfaces to other equipment. (e.g. boilers, chillers, etc.). Securely attach to the inside of the respective control cabinet.

4.6.7.12 Provide lamcoid labels indicating the required operating sequences, on the boilers and valves, where the boiler plants have manual or automatic isolating valves. Submit actual wording to the Consultant for approval prior to fabrication and installation.

4.6.7.13 Provide lamcoid or machine labels (as outlined above) for all interposing relays or contactors used in control circuits. The labels shall include the related point software name and hardware address.

4.6.7.14 Provide a lamcoid label to identify the location of concealed devices above the ceiling space. Mount the label on the ceiling grid t-bar or a permanent surface adjacent to the devices. The label shall contain the wording “BAS Devices Above”.

4.6.7.15 Provide lamcoid labels for all auxiliary HVAC equipment (e.g. force flow cabinets, unit ventilators, unit heater, window AC units, etc.) controlled by the BAS. Mount the labels in the vicinity of the existing thermostat or power switch for the unit. The label shall contain the wording “Under BAS Control”.

4.6.7.16 Where directed by the Consultant, provide any and all additional labeling, diagrams, schematics or instructions as may be required to facilitate the correct operation and maintenance of controlled building systems.

4.6.8 Systems Hardware Commissioning

4.6.8.1 This contractor shall be responsible for the “end to end” commissioning, testing, verification and start-up of the complete control system hardware including panels, sensors, transducers, end devices, relays and wiring. Where applicable, this shall include any points from an existing and/or re-used automation system in the building.

4.6.8.2 The Contractor shall prepare a hardware commissioning report containing the following information and test results:

- Analogue inputs (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual temperature readings should be within +/- 1C of the readings observed at the workstation. Record calibration adjustments and settings.
Analogue outputs shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0-100% range from a minimum control range of 10-90%. Record the actual output scale range (channel output voltage versus controller command) for each analogue end device.

Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.

Digital inputs shall be verified by witnessing the status of the input point as the equipment is manually cycled on and off.

Record all out-of-season or unverified points in the commissioning report as “non-commissioned”.

Identify any existing equipment (valves, dampers, fan starters, etc.) that are inoperative or require maintenance or repair.

The BAS field panel power source shall be toggled on and off to ensure reboot functionality and power down memory retention of all parameters. During the power down test, all controlled system outputs shall go to their fail-safe position.

Verify PID loop tuning parameters by applying a step change to the current setpoint and observing the response of the controlled device. Setpoint should be reached in an acceptable period of time without excessive cycling or hunting of the controlled device. Provide a graph of the trend response to setpoint change for important controlled devices (e.g. valves 1-inch or larger, dampers on major air handlers, etc.)

Provide confirmation that a series of test alarms has been successfully received at a designated remote monitoring workstations.

Include with the hardware commissioning report a site floor plan indicating the location of all equipment installed in concealed or recessed locations (e.g. interposing relays in ceiling spaces).

Provide testing of all LAN cabling to ensure that 100Mb bandwidth is supported.

Verify conformance with TIA /EIA TSB-67 - Basic Link Test using a Level 2, bi-directional tester. Provide all equipment necessary to carry out the required tests.
- The hardware commissioning report must be signed and dated by the Contractor’s technician performing the tests and participating Go Transit trades staff.

- At the completion of site commissioning, submit four (4) copies of hardware commissioning report to Go Transit.

4.6.9 Substantial Completion Inspection

4.6.9.1 At the completion of the site hardware inspection, the Contractor shall test and verify that the system programming, graphics and alarm software is operating correctly and is in compliance all requirements of the specifications.

4.6.9.2 The Contractor shall provide written notification to the Go Transit that the site is ready for the Substantial Completion Inspection by the Consultant

4.6.9.3 issue a comprehensive site deficiency report to the Contractor for his immediate action.

4.6.9.4 The Contractor shall correct all items noted in the site deficiency report within ten (10) business days of receipt.

4.6.9.5 The Contractor shall provide written notification to the Go Transit that all items on the Consultant’s site deficiency report have been corrected.

4.6.10 Training

4.6.10.1 Provide four (4) hours of operator training and four (4) hours of advanced maintenance level training per facility. The allocation of training hours and the number of participants shall be determined by Go Transit. The training hours may be divided up over several training sessions. The number of trainees to be determined by Go Transit but shall not exceed 8 for any one session. Training may take place on site, at another Go Transit location, at the Contractor’s office or any combination thereof.

4.6.10.2 Submit a proposed training lesson plan for each session the Go Transit for review and approval.
PART 1  GENERAL

1.1  GENERAL

1.1.1  This section of the specification shall be read in conjunction with and be governed by the requirements outlined in Section 15010.

1.2  REFERENCES

1.2.1  CGSB 24-GP-3a - Identification and Classification of Piping Systems.

1.3  EQUIPMENT

1.3.1  Manufacturer's nameplates:

   1.3.1.1  Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.

   1.3.1.2  Provide Underwriters' Laboratories or CSA registration plates, as required by respective agency.

   1.3.1.3  Manufacturers nameplate to indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

   1.3.1.4  Locate nameplates so that they are easily read. Do not insulate or paint over plates.

1.3.2  System nameplates:

   1.3.2.1  Provide laminated plastic plates with black face and white centre of minimum size 90 x 40 x 2.5 mm nominal thickness, engraved with 6 mm high lettering. Use 25 mm lettering for major equipment.

   1.3.2.2  Fasten nameplates securely in conspicuous place. Where nameplates can not be mounted on cool surface, provide standoffs.

   1.3.2.3  Identify equipment type and number (eg Pump No. 2) and service or areas or zone of building served eg "Perimeter Heating".

   1.3.2.4  Submit list of nameplates for review prior to engraving.
1.4  **PIPING**

1.4.1 Identify medium in piping with markers showing name and service including temperature, pressure and directional flow arrows in accordance with CGSB 24-GP-3a.

1.4.2 Block capital letters 2" high for pipes of 3" nominal and larger including insulation and not less than 3/4" high for smaller diameters.

1.4.3 Direction arrows 6" long by 2" wide for piping of 3" nominal or larger including insulation and 4" long by 3/4" wide for smaller diameters. Use double headed arrows where direction of flow is reversible.

1.4.4 Waterproof and heat resistant plastic marker tags for pipes and tubing 3/4" nominal and smaller.

1.4.5 Black pipe marker letters and direction arrows, white on red background for fire protection pipe markers.

1.4.6 Standard of Acceptance: WH Brady identification tapes, bands, markers; Seton Name Plate Corporation; Setmark pipe markers.

1.5  **LOCATION:**

1.5.1 Locate markers and classifying colours on piping systems so they can be seen from floor or platform.

1.5.2 Piping runs at least once in each room.

1.5.3 Maximum 45 ft between identifications in open areas.

1.5.4 Both sides where piping passes through walls, partitions and floors.

1.5.5 At point of entry and leaving, where piping is concealed in pipe chase or other confined space, and at each access opening.

1.5.6 At start and end points of runs and at each piece of equipment.

1.5.7 At major manual and automatic valves immediately upstream of valves.

1.5.8 Identify branch, equipment or area served after valve.
1.6 **VALVES AND CONTROLLERS**

1.6.1 Provide brass tags with 12 mm stamped code lettering and numbers filled with black paint, secured with non-ferrous chains or "S" hooks for valves and operating controllers except at plumbing fixtures and radiation.

1.6.2 Provide Consultant with six identification flow diagrams of approved size for each system. Include tag schedule, designating number, service, function, and location of each tagged item and normal operating position of valves.

1.6.3 Install where directed one copy of flow diagram and valve schedule mounted in glazed frame. Provide one copy in each operating and maintenance instruction manual.

1.6.4 Consecutively number valves in systems.

1.7 **CONTROLS**

1.7.1 Refer to section 15020
PART 1  GENERAL

1.1  GENERAL

1.1.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2  SHOP DRAWINGS

1.2.1 Submit shop drawings in accordance with Section 15010.

1.2.2 Provide separate shop drawings for each isolated system complete with performance and product data.

1.2.3 Submit type of isolator, size, height when uncompressed and maximum allowable static deflection weight of all isolated equipment, loads on each isolator and static deflection of each isolator under the specific design load.

1.2.4 Submit marked up plans indicating all locations where pipes are to be isolated in mechanical rooms and as specified.

PART 2  PRODUCTS

2.1  GENERAL

2.1.1 Vibration isolator sizes and layout shall be determined by the vibration isolator supplier.

2.1.2 All mechanical equipment not specifically identified in this specification that contains rotating or vibrating elements shall be installed on Type P1 isolators (see below).

2.1.3 Elastomeric elements that will be exposed to temperatures below freezing shall be fabricated from natural rubber instead of neoprene.


2.2  FLEXIBLE PIPE CONNECTIONS

2.2.1 Flexible pipe connectors shall be used on all piping connected to rotating equipment (pumps) to reduce the transmission of noise and vibration, and to eliminate stresses in piping systems due to misalignment and thermal movement of the piping.
2.2.2 Flexible connectors shall be of the single- or double-sphere molded joint configuration and shall meet or exceed specifications of the Rubber Expansion Joint Division, Fluid Sealing Association.

2.2.3 Connectors shall be made of molded neoprene reinforced with nylon tire cord and shall have mild steel floating flanges or female union ends.

2.2.4 Control rods shall be used with unanchored systems or with spring-mounted equipment where the pressures and movements exceed those the connectors are designed to withstand.

2.2.5 Standard of acceptance: Kinetics model Kinflex

2.3 PUMPS ELASTOMERIC PADS

2.3.1 Type P1 - neoprene waffle or ribbed; 9mm minimum thick; 50 durometer; maximum loading 350 kPa. Mason type W

2.3.2 Application: between the pumps supports and the housekeeping pad.

2.4 BOILER ELASTOMERIC PADS

2.4.1 Type P2 - Isolation pads shall be a homogeneous blend of ozone-resistant rubber elastomer and high-strength random synthetic fiber cords cured together to form a durable material with uniform behaviour in all directions suitable to support isolated equipment loads.

2.4.2 Isolation pads shall conform to the specified ASTM and other material test requirements in all directions perpendicular to the pad’s thickness. Isolation pads shall be of the size and thickness specified or shown by the contract drawings. Unloaded thickness tolerance shall be within 15% or ±1/16 inch, (2 mm) whichever is greater.

2.4.3 Compressive stress on the isolation pad shall be limited to 2000 psi (141 kg/cm²) for static loading and 1000 psi (70 kg/cm²) for shock or vibration applications. Technical specifications for the isolation pad material shall be as tabulated.

2.4.4 Standard of Acceptance: Kinetics Noise Control Model NDM

2.5 PIPE HANGERS

2.5.1 Colour coded springs, rust resistant, painted box type hangers. Swivel arrangement to permit hanger box or rod to move through a 30 deg. arc without metal to metal contact. Unless specified otherwise, the static deflection shall be 9mm, with a strain not exceeding 15%, and spring hangers to have minimum static deflection of 2". A neoprene
sleeve shall be provided where the lower hanger rod passes through the steel hanger box such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19mm larger than the diameter of the hanger rod.

2.5.2 Standard of acceptance: Kinetics model SRH

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Provide vibration isolation for new equipment as noted in the specification, listed in the schedule and shown on the drawings.

3.1.2 instructions and adjust mountings to level equipment.

3.1.3 Ensure piping and electrical connections to isolated equipment do not reduce system flexibility.

3.1.4 All suction and discharge from the pumps shall be provided with flexible pipe connections.

3.1.5 Unless indicated otherwise, support all piping connected to the boiler with spring equipped hangers as described in these specifications, as follows:

3.1.5.1 First 3 points of support.

3.1.5.2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 2".

3.1.6 Unless specified otherwise, all pump supports will be mounted P-1 pads.

3.1.7 Unless specified otherwise, the boilers will be mounted on neoprene pads type P-2.

3.1.8 All wiring connections to the pumps shall be made in a 360 degree loop; minimum conduit length: 3 ft. Cut any ties used to install this loop prior to adjusting the isolators.

3.1.9 Provide suitable supports for all equipment which does not have a frame with adequate rigidity.

3.1.10 There shall be a minimum of 4" clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
3.1.11 Piping, ductwork, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes or ductwork installed on vibration isolators. It shall be supported on or suspended from building structure.
PART 1  GENERAL

1.1  GENERAL

1.1.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2  QUALITY ASSURANCE

1.2.1 Comply with OBC and NFPA 90A requirements, particularly paragraphs pertaining to the maximum flame spread index (currently set at 25) and maximum smoke development index (currently set at 50).

1.2.2 All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

1.2.3 Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.3  SUBMITTALS

1.3.1 Submit in accordance with Section 15010 shop drawings and product data

1.3.2 Provide the following:

1.3.2.1 Insulation materials: Specify each type used and state surface burning characteristics.

1.3.2.2 Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.

1.3.2.3 Insulation accessory materials: Each type used.

1.3.2.4 Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.

1.4  STORAGE AND HANDLING OF MATERIAL

1.4.1 Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.
1.5 STANDARDS OF ACCEPTANCE

1.5.1 Knauf Fiber Glass
1.5.2 Owens/Corning Fiberglass
1.5.3 Armstrong
1.5.4 Johns Manville
1.5.5 Rockwool Manufacturing
1.5.6 Armaflex.

PART 2 PRODUCTS

2.1 GENERAL

2.1.1 K-factors (thermal conductivity) shown are expressed in BTU•in/hr•ft²•F.

2.2 FIBERGLASS PIPE INSULATION WITH VAPOUR BARRIER

2.2.1 Rigid molded in compliance with ASTM C547, Class 1, minimum density 3.5 pounds/cubic foot, K-factor of approximately 0.24 at 75 degrees F, suitable for temperatures from minus 20 degrees F to 450 degrees F.

2.2.2 Vapor Barrier: Factory applied vapor barrier all-service type with self-sealing lap and butt strips.

2.2.3 Valves and Fitting Covers: Pre-molded PVC covers with fiber glass insert. Manufacturers: Proto Corp., Cielco.

2.2.4 Applications

2.2.4.1 All hot water/hot glycol piping
2.2.4.2 All domestic cold water piping

2.3 INSULATION THICKNESS

2.3.1.1 Hot water/glycol heating less than 2” diam: 1”
2.3.1.2 Hot water/glycol heating, larger than 2” diam: 1½”
2.3.1.3 Domestic cold water, less than 2” diam.: ½”

2.4 ADHESIVE, MASTIC, CEMENT

2.4.1 ASTM C449: Mineral fiber hydraulic setting thermal insulating and finishing cement.

2.4.2 Other: Insulation manufacturers' published recommendations.
2.5 **MECHANICAL FASTENERS**

2.5.1 Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.

2.5.2 Bands: 20 mm (3/4 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.6 **CANVAS JACKETING**

2.6.1 Apply in all exposed areas, including mechanical rooms: compact, firm ULC listed heavy plain weave, cotton fabric at 220 g/m sq.

2.7 **METAL JACKETING**

2.7.1 At all locations where the pipe is located outdoors or in heavy abuse areas, use metal jacketing to protect piping or ductwork insulation.

2.7.2 Jacketing: Aluminum, 0.016 inches thick, embossed surface, with factory bonded moisture barrier.

2.7.3 Valve and Fitting Insulation Covers: Fabricate from same material as jacketing or use prefabricated insulation covers made in two matching halves.

2.7.4 Metal Jacketing Bands: 1/2 inch wide, aluminum or stainless.

2.8 **PROTECTION SADDLES AND SHIELDS**

2.8.1 Provide factory engineered galvanized steel hanger shields on horizontal insulated pipe complying with MSS SP-58 and MSS SP-59 standards for gauge and length of saddle.

2.9 **SADDLES (PIPING/TUBING UP TO 2 INCHES)**

2.9.1 Use 180 degree saddle on systems utilizing teardrop type hangers.

2.9.2 Use 360 degree saddle on systems utilizing trapeze hangers or clamps.

2.10 **INSERTS AND SHIELDS (PIPING/TUBING OVER 2: DIAM.)**

2.10.1 Use 360 degree calcium silicate insert with a 180 degree shield on systems utilizing clevis or teardrop type hangers.

2.10.2 Use 360 degree calcium silicate with a 360 degree shield on systems utilizing trapeze hangers or clamps.
2.10.3 The unit shall have an integral moisture barrier consisting of a tri-laminate All-Service Jacket equal and similar to the jacketing on the adjoining insulation.

2.10.4 Insert: Calcium silicate, minimum density 9 pounds/cubic foot.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verify that items to be insulated have been pressure tested and approved before applying insulation material.

3.1.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION - GENERAL

3.2.1 Install materials in accordance with manufacturer's instructions.

3.2.2 Required pressure tests of piping joints and connections shall be completed and the work approved by the Consultant for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

3.2.3 Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories). Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.

3.2.4 Insulation materials shall be installed with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

3.2.5 Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.

3.2.6 Construct insulation on parts of equipment that must be opened periodically for maintenance or repair so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
3.2.7 Insulation on hot piping and equipment shall be terminated square at items not to be insulated, such as access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.

3.2.8 Piping work not to be insulated:

3.2.8.1 In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves. Insulate piping to within approximately 25 mm (1") of uninsulated items.

3.2.9 Work shall be performed by qualified insulation journeymen.

3.2.10 Apply insulation and coverings on hot piping while surface is between 120 and 140°F.

3.2.11 Vapour barriers and insulation to be complete over full length of pipe or surface, without penetration for hangers, and without interruption at sleeves, pipe and fittings.

3.2.12 Do not insulate factory-insulated equipment.

3.2.13 Do not insulate nameplates.

3.2.14 Fit insulation tightly against surface to which it is applied.

3.2.15 For non-fire rated barriers (e.g., wall, floor, ceiling, or roof) continue insulation and vapor barrier through penetrations. For fire rated barriers, provide ULC/FM approved through penetration stop systems.

3.2.16 Weatherproof outdoor installations of piping or ductwork covered with aluminum jacket. Provide watershed lap joints and seal with mastic as required. Secure with aluminum bands and screws as required.

3.2.17 Do not install metal jacketing with raw edges; provide a safety edge.

3.3 INSTALLATION - PIPING

3.3.1 On exposed piping located in finished areas, locate cover seams in least visible area.

3.3.2 Provide continuous insulation through pipe hangers or supports. Do not notch insulation. Provide shields or saddles to prevent crushing insulation.

3.3.3 Where insulation terminates, taper to pipe and finish with insulating cement or acrylic mastic.
3.3.4 Insulate fitting and valves where required with same material thickness as specified for adjacent pipe.

3.3.5 Vertical pipe over 3" diam: use insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter locate on 12 ft centres and at each valve and flange.

3.3.6 Expansion joints: Terminate single layer and each layer of multiple layers in straight cut. Leave space of 1” between terminations. Pack void tightly with glass wool. Protect joints with aluminum sleeves.

3.3.7 Use factory fabricated, easily disassembled insulation, for valves, fittings and process equipment requiring periodic maintenance of parts and sub-assemblies listed or indicated.
PART 1    GENERAL

1.1    DESCRIPTION

1.1.1    Domestic water systems, including piping, equipment and all necessary accessories as designated in this section

1.2    REFERENCE STANDARDS

1.2.1    Do the work in accordance with Plumbing Code under the Ontario Building Code and Local Authority Having Jurisdiction.

1.2.2    ASTM B88-83.

1.3    SUBMITTALS

1.3.1    Submit in accordance with Section 15010 Manufacturer's Literature and Data for:

1.3.1.1    Piping.
1.3.1.2    Strainers.
1.3.1.3    Valves
1.3.1.4    Water Hammer Shock Absorbers
1.3.1.5    Backflow Preventers

PART 2    PRODUCTS

2.1    WATER SERVICE CONNECTIONS TO BUILDINGS

2.1.1    From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building and underground inside building, material selected shall be the same for the size specified.

2.1.2    75 millimeters (3 inch) diameter and over: Ductile iron, AWWA C151, 850 kPa (125 pounds) water steam pressure (WSP), exterior bituminous coating, cement lined. Provide flanged and anchored connection to interior piping.

2.1.3    Under 75 mm (3 inch) diameter: Copper tubing, ASTM B88, Type K, seamless, annealed. Fittings as specified herein. Use brazing alloys, AWS A5.8, Classification BcuP.

2.1.4    Flexible Expansion Joint: Ductile iron with ball joints rated for 1725 kPa (250 psi) working pressure conforming to ANSI/AWWA A21.53/C153, capable of deflecting a minimum of 30 degrees and expanding simultaneously to the amount shown on the drawings. Flexible expansion joint shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum
of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory holiday tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA A21.11/C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene.

2.2 INTERIOR DOMESTIC WATER PIPING

2.2.1 Pipe: Copper tube, ASTM B88, Type L, hard drawn.

2.2.2 All piping shall have certification markings for compliance with ASTM B88-83.

2.2.3 Fittings for Copper Tube:

2.2.3.1 Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 & SP 110, Solder or braze joints.

2.2.3.2 Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.

2.2.4 Adapters: Provide adapters for joining screwed pipe to copper tubing.

2.2.5 For installation of the potable water system only lead free solder shall be used, as required by the Ontario Act. Regulation 815/84 of the Ontario Water Resources.

2.2.6 Solder, tin antimony, 95:5: to ASTM B32-83. Provide non corrosive flux.

2.2.7 Brazing alloy: AWS A5.8, Classification BcuP.

2.3 TRAP PRIMER WATER PIPING:

2.3.1 Pipe: Copper tube, ASTM B88, type K, hard drawn.

2.3.2 Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.

2.3.3 Solder: ASTM B32 composition Sb5. Provide non-corrosive flux.

2.4 WATERPROOFING

2.4.1 Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
2.4.2 Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

2.5 STRAINERS

2.5.1 Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage, upstream of back-flow preventer assemblies and where shown on drawings. Strainer element shall be removable without disconnection of piping.

2.5.2 Water: Basket or "Y" type with easily removable cover and brass strainer basket.

2.5.3 Body: Smaller than 75 mm (3 inches), brass or bronze; 75 mm (3 inches) and larger, cast iron or semi steel.

2.6 DIELECTRIC FITTINGS

2.6.1 Provide dielectric couplings or unions between ferrous and non ferrous pipe.

2.7 STERILIZATION CHEMICALS

2.7.1 As required by Authorities having Jurisdiction, or:

2.7.1.1 Liquid Chlorine: ASTM E1120.
2.7.1.2 Hypochlorite: ASTM E1229, or Fed. Spec. AA-1427C, grade B.

2.8 WATER HAMMER ARRESTER:

2.8.1 Closed copper tube chamber with permanently sealed 410 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved Dow Corning No. 11 silicone compound. All units shall be designed in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and install in accordance with Plumbing and Drainage Institute requirements (PDI WH 201). Provide water hammer arrestors at all solenoid valves, at all groups of two or more flush valves, at all quick opening or closing valves.

2.8.2 Standard of Acceptance: Watts, Precision Plumbing Products

2.9 VALVES

2.9.1 General

2.9.1.1 Asbestos packing is prohibited.
2.9.1.2 Standard of Acceptance: Jenkins, Crane, Toyo, Kitz

2.9.2 Shut off Valves, Cold, Hot and Recirculating Hot Water:

2.9.2.1 50 millimeter (2 inches) and smaller:

- Ball, Mss SP-72, SP-110, Type II, Class 125, Style 1, three piece or double union end construction, full ported, full flow, with solder end connections, 2750 kPa (400 psi) WOG, MSS-SP-67.

2.10 WATER PRESSURE REDUCING VALVE AND CONNECTIONS

2.10.1 Single-seated, for dead end service for 200 to 850 kPa (30 to 125 pounds) range on low pressure side. Composition diaphragm and stainless steel springs, bronze body with threaded connections for sizes 15 to 55 mm (1/2 to 2 inch), cast iron or semi-steel body with brass or bronze trimmings and flanged connections for sizes 15 to 50 mm (2-1/2 to 4 inch).

2.10.2 Operation: Diaphragm and spring to act directly on valve stem. Delivered pressure shall vary not more than one kPa for each 10 kPa (one pound for each 10 pounds) variation on inlet pressure.

2.10.3 Connections Valves and Strainers: Install shut off valve on each side of reducing valve and full sized bypass with globe valve. Install strainer on inlet side of, and same size as pressure reducing valve. Install pressure gage on low pressure side of line.

2.11 BACKFLOW PREVENTERS

2.11.1 Provide a backflow prevention device at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination.

2.11.2 Water make up to heating systems, cooling tower, chilled water system:

2.11.2.1 Provide assembly with integral shutoff valves that conform to ASSE 1015 and AWWA C510. The assembly shall have top entry access points for each check assembly, screw driver slotted test cocks and require the use of no special tools for servicing. All wetted rubber parts shall be manufactured from silicone or chloramine resistant EPDM rubber. All valve seats and seat discs shall be replaceable. Seat discs shall be reversible to extend check valve life. Check valve guiding shall be plastic to plastic.

2.11.2.2 Standard of Acceptance: Watts Series 719.
2.11.3 Water service entrance immediately downstream of water meter.

2.11.3.1 Assembly consists of two independently operating check valves, two shutoff valves, and four test cocks. It may be installed vertical or horizontal, under continuous pressure service and may be subjected to back pressure and back siphonage.

2.11.3.2 Double check valve assembly shall consist of two independent tri-link check modules within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Tri-link checks shall be removable and serviceable, without the use of special tools. The housing shall be constructed of 304 Schedule 40 stainless steel pipe with groove end connections. Tri-link checks shall have reversible elastomer discs and in operation shall produce drip tight closure against reverse flow caused by back pressure or back siphonage.

2.11.3.3 Standard of Acceptance: Watts series 757.

2.11.4 Atmospheric Vacuum Breaker: ASSE 1001

2.11.4.1 Application: Hose bibs and sinks w/threaded outlets.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

3.1.1 Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.

3.1.2 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.

3.1.3 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.

3.1.4 All pipe runs shall be laid out to avoid interference with other work.

3.1.5 Install union and shut-off valve on pressure piping at connections to equipment.

3.1.6 Pipe Hangers, Supports and Accessories:

3.1.7 All piping shall be supported per of the Ontario Plumbing Code and section 15010. The most restrictive requirements shall apply.
3.1.8 Penetrations:

3.1.8.1 Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases.

3.1.8.2 Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant.

3.1.9 Piping shall conform to the following:

3.1.9.1 Where possible, grade all lines to facilitate drainage. Provide drain valves at bottom of risers. All unnecessary traps in circulating lines shall be avoided.

3.1.9.2 Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

3.2 PRESSURE TESTS

3.2.1 General: Test system either in its entirety or in sections.

3.2.2 Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 690 kPa (100 psi) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.

3.3 STERILIZATION

3.3.1 After pressure tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with the requirements of Authorities Having Jurisdiction.

3.3.2 Use either liquid chlorine or hypochlorite for sterilization.

3.4 VALVES INSTALLATION

3.4.1 Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible. Install valve in each water connection to fixture.

3.4.2 Install union and shut-off valve on piping at connections to equipment and at all other locations indicated on the drawings.
PART 1    GENERAL

1.1    GENERAL

1.1.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2    REFERENCE STANDARDS

1.2.1 Do HVAC fluid chemical treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of regulating authorities, except where specified otherwise.

1.3    SHOP DRAWINGS

1.3.1 Submit shop drawings in accordance with Section 15010.

1.4    MAINTENANCE DATA

1.4.1 Provide maintenance data for water treatment equipment for incorporation into maintenance manual specified in Section 15010.

PART 2    PRODUCTS

2.1    MANUFACTURER

2.1.1 Equipment, chemicals and service by one manufacturer.

2.1.2 Standard of Acceptance: Drew Chemicals, Kelnzoid, Betz

2.2    CLEANING COMPOUNDS

2.2.1 Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.

2.2.2 All chemicals to be acceptable for discharge to sanitary sewer.

2.2.3 Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved proprietary compound suitable for make up quality and make up rate and which will not cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by chemical treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.
2.2.4 PH Control: Inhibitor formulation shall include adequate buffer to maintain pH in the range recommended by the boiler manufacturer.

2.2.5 Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

2.3 PIPING

2.3.1 Chemical feed piping, schedule 80 black steel, crosses at all changes in direction with unconnected ports plugged.

2.4 POT FEEDER

2.4.1 Malleable cast iron or bronze, ASE Specifications S-15, pressure rating 1200 kPa, temperature rating 110C.

2.4.2 The feeder shell shall be constructed of 10 gauge steel minimum. Tank heads shall be a minimum of 9 gauge steel.

2.4.3 The tank shall have a wide mouth, 3½" opening so that chemical addition can be performed without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring 2½ turns to close and seal. Closures using partial threads or lugs shall not be considered. Closures rated less than 300 psi shall not be considered equal.

2.4.4 The cap shall be constructed of cast iron with an epoxy-coated underside to prevent corrosion and shall use a square ring gasket seal. The ring gasket shall not be glued or restrained from movement. Closures using “O” rings or gaskets which are glued or restrained from free movement by snap rings shall not be considered equal.

2.4.5 By pass type, complete with necessary shut off valves, drain and air release valves, and system connections, for introducing chemicals into system, with funnel or large opening on top for easy chemical addition. Feeders shall be 18.9 L (five gallon) minimum capacity

2.4.6 Standard of Acceptance: Neptune FTF series
2.5 **BYPASS FILTER**

2.5.1 Brass housing, integrated sludge and bubble trap system with round brush of corrugated stainless steel wire. Built-in quick ventilator; large hand wheel with ball valve operation of return flushing with simultaneous mechanical cleaning of the brush body. Built-in rotary flange with bayonet connection and screw fittings. Thread connection to DIN 2999, heat insulation.

2.5.2 Filter unit to be 5% of total recirculation rate for all closed systems.

2.5.3 Standard of Acceptance: Judo JHF-T series.

2.6 **TANKS**

2.6.1 Polyethylene; high density, 200 litre capacity.

2.7 **GLYCOL AUTOMATIC FILLING STATION**

2.7.1 Supply and install glycol autofill unit complete with 53 Gallon (200 liter) mixing tank capacity and filling pump to control and provide expansion and maintain the glycol system pressure by providing glycol make-up automatically upon a drop in system pressure, for the following sealed system parameters:

- **2.7.1.1** Total system liquid content: 235 gallons
- **2.7.1.2** System flow temperature 48°F
- **2.7.1.3** Static height above glycol/expansion tank unit: 40 feet
- **2.7.1.4** Total chiller capacity: as indicated in the equipment schedules
- **2.7.1.5** Maximum system operating pressure at glycol/expansion tank unit: 60 feet

2.7.2 Materials of construction:

- **2.7.2.1** Tank: polypropylene
- **2.7.2.2** Frame: mild steel
- **2.7.2.3** Pump construction: all-bronze
- **2.7.2.4** Water fill connection: ball valve 304 stainless steel ball, brass body
- **2.7.2.5** Glycol fill connection: ball valve 304 stainless steel ball, brass body
- **2.7.2.6** Interconnecting piping: galvanized
- **2.7.2.7** Control circuit voltage: 24V

2.7.3 The glycol auto fill unit shall be provided with the following standard features:

- **2.7.3.1** Unit shall monitor and maintain the minimum system pressure at all times
- **2.7.3.2** Low mixture cut-out level switches shall monitor the status of the mixing tank
- **2.7.3.3** Level switches shall be 24 volt maximum to ensure intrinsic electrical safety
2.7.3.4 Pump suction isolation valve  
2.7.3.5 Pump suction strainer  
2.7.3.6 Single phase power connection  
2.7.3.7 45 psi (300 kPa) fill pressure  
2.7.3.8 Glycol auto-mix (to prevent settling)  
2.7.3.9 High level alarm  
2.7.3.10 Contacts for remote annunciation

2.7.4 Standard of Acceptance:

2.7.4.1 Armstrong GLA Ultra

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.1.2 Pipe blow-off connections to nearest drain.

3.1.3 Supply and install all power and control wiring to the glycol equipment as required to make it completely operational.

3.2 CHEMICAL TREATMENT SERVICES

3.2.1 Provide chemical treatment monitoring and consulting services for a period of one year after system start-up. Service to include:

3.2.1.1 Initial fluid analysis and treatment recommendations.
3.2.1.2 System start-up assistance.
3.2.1.3 Operating staff training.
3.2.1.4 Visit plant once each week during period of operation and as often as required until the system stabilizes, and advise on treatment system performance.
3.2.1.5 Provide necessary recording charts and log sheets for one year operation.
3.2.1.6 Provide all necessary laboratory and technical assistance.
3.2.1.7 Instructions and advice to operating staff to be clear and concise and in writing.

3.2.2 Provide one year’s supply of chemicals for control of scale, sludge and corrosion.

3.2.3 Provide material safety data sheets for chemicals and reagents.
3.3 **PRE-OPERATIONAL CLEANING OF SYSTEM**

3.3.1 Provide a copy of recommended cleaning procedures and chemicals for approval by Consultant.

3.3.2 Prior to chemical cleaning, the systems shall be inspected to ensure removal of heavy debris and excessive dirt and oil. Temporary strainers shall be installed on the suction side of each pump.

3.3.3 Provisions shall be made for temporary connections between the supply and return mains in the system to permit circulation of the cleaner. A 1" pipe connection shall be provided on the suction side of the circulating pumps for introduction of the cleaning solution.

3.3.4 Each system shall be flushed to remove loose dirt and shall be hydrostatically tested to ensure that there are no leaks. Rotation of pumps shall be checked.

3.3.5 The contractor shall introduce a neutral pH cleaner and rust remover into each system at a dosage recommended by the water treatment supplier. The cleaner shall not attack carbon steel, copper, stainless steel, bronze, brass, aluminum, plastics or natural and synthetic rubbers. “Flash rusting” shall not occur after cleaning.

3.3.6 The cleaner shall be circulated at a temperature of 10°C to 80°C for a period of not less than 72 hours. PH adjustment shall be carried out by the water treatment supplier’s representative.

3.3.7 Each system shall be drained, refilled with fresh water, recirculated for a period of 12 hours, drained a second time, and immediately refilled and treated with the recommended corrosion inhibitor.

3.3.8 The water treatment company shall provide the loan of a drum pump and dolly to facilitate the introduction of the cleaner into the system.

3.4 **BOIL OUT OF NEW BOILERS**

3.4.1 Provide softened water for boiling out new boilers.

3.4.2 Provide chemicals and labour for boiling out new boilers.

3.4.3 Boil out each new boiler with an alkaline boil out compound containing an embrittlement inhibitor.
3.4.4 Operate each boiler at sufficient pressure (30% - 50% of operating pressure) to ensure good temperature elevation and good circulation. Provide a temporary line to atmosphere to enable a “false load” to be imposed on the boiler.

3.4.5 The boil out period shall be of not less than 48 hours duration, or until all contaminants have been removed.

3.4.6 The method of boiling out shall not conflict with the boiler manufacturer’s standard boil out instructions.

3.4.7 At the conclusion of the boil out, the boiler shall be cooled down and de-concentrated by alternately “blowing down” and “making up” with softened water.

3.4.8 When the boiler water alkalinity has been reduced to that of the makeup water, the boiler pressure shall be relieved, and the boiler drained and flushed immediately with treated water.

3.5 GLYCOL AUTOMATIC FILL STATION

3.5.1 Install in accordance to the manufacturer’s instruction. Provide concrete support pad.

3.5.2 Connect to power supply and controls, including tie-in to the school BAS (where applicable).

3.5.3 Contractor to provide a full charge of glycol, of the type and concentration specified.

3.5.4 Start-up and adjustment: by equipment manufacturer. Cost to be covered by the mechanical contractor.

3.5.5 Install in accordance to the manufacturer’s instruction. Provide concrete support pad.

3.5.6 Connect to power supply and controls; including tie-in to the owner’s building automation system

3.5.7 Start-up and adjustment: by equipment manufacturer. Cost to be covered by the mechanical contractor.
PART 1  GENERAL

1.1  DESCRIPTION

1.1.1  Fuel gas systems, including piping, equipment and all necessary accessories as designated in this section.

1.2  SUBMITTALS

1.2.1  Submit in accordance with Section 15010, shop drawings, product data, and samples.

1.2.2  Manufacturer’s Literature and Data:

   1.2.2.1  Piping.
   1.2.2.2  Strainers.
   1.2.2.3  All items listed in Part 2 - Products.
   1.2.2.4  Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

1.3  APPLICABLE PUBLICATIONS

1.3.1  The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

1.3.2  CAN1-B149.1-M80 for natural gas

1.3.3  Ontario Natural Gas Code

1.3.4  National Fire Protection Association (NFPA)

PART 2  PRODUCTS

2.1  FUEL GAS SERVICE CONNECTIONS TO BUILDING

2.1.1  From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building, use coated piping.

2.1.2  Pipe: Black steel, ASTM A53, Schedule 40. Shop-applied pipe coating shall be one of the following types:

   2.1.2.1  Coal Tar Enamel Coating: Exterior of pipe and fittings shall be cleaned, primed with Type B primer and coated with hot-applied coal tar enamel with bonded layer of felt wrap in accordance with AWWA C203. Asbestos felt shall not be
used; felt material shall be fibrous glass mat as specified in Appendix Section A2.1 of AWWA C203.

2.1.2.2  Adhesive-thermoplastic Resin Coating: Fed. Spec. L-C-530, Type I.

2.1.2.3  Thermosetting Epoxy Coating: Fed. Spec. L-C-530, Type II.

2.1.2.4  Field-applied plastic tape material used on pipe joints and for repairing damaged areas of shop-applied coatings, Fed. Spec. L-T-1512, Type I, 10 mils nominal thickness for pipe joints, and Type II, 20 mils nominal thickness for coating repairs.

2.1.3  Fittings:

2.1.3.1  Butt weld fittings, wrought steel, ANSI B16.9.

2.1.3.2  Socket weld and threaded fittings forged steel, ANSI B16.11.

2.1.3.3  Grooved End: Ductile iron (ASTM A536, Grade 65-45-12), malleable iron (ASTM A47, Grade 32510), or steel (ASTM A53, Type F or Type E or S, Grade B).


2.2  FUEL GAS PIPING ABOVE-GROUND

2.2.1  Pipe: Black steel, ASTM A53, Schedule 40, seamless as follows:

2.2.2  ½” to 1½” diam, screwed.

2.2.3  2” to 10” welded, plain end..

2.2.4  Nipples: Steel, ASTM A733, Schedule 40.

2.2.5  Pipe fittings, screwed, flanged or welded as follows:

2.2.5.1  Malleable iron screwed fittings (banded): Class 150 to ANSI B16.3-1977.

2.2.5.2  Steel pipe flanges and flanged fittings: to ANSI B16.5-1977.

2.2.5.3  Steel butt-welding fittings: to ANSI B16.9-1978.

2.2.5.4  Unions, malleable iron, brass to iron, ground seat: to ANSI B16.3-1977.

2.2.5.5  Bolts and nuts: to ANSI B18.2.1-1972 and ANSI B18.2.2-1972.

2.2.5.6  Nipples, Schedule 40: to ASTM A53-82.

2.2.6  Joints: Provide welded or threaded joints
2.3 JOINTING MATERIAL

2.3.1 Screwed fittings: pulverized lead paste.

2.3.2 Welded fittings: to CSA W47.1-1983.


2.4 WATERPROOFING

2.4.1 Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.

2.4.2 Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

2.5 STRAINERS

2.5.1 Provide on high pressure side of pressure reducing valves, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.

2.5.2 Gas Lines: "Y" type with removable mesh lined brass strainer sleeve.

2.5.3 Body: Smaller than 80 mm (3 inches), brass or bronze; 80 mm (3 inches) and larger, cast iron or semi steel.

2.6 DIELECTRIC FITTINGS

2.6.1 Provide dielectric couplings or unions between ferrous and non ferrous pipe.

2.7 GAS EQUIPMENT CONNECTORS

2.7.1 Flexible connectors with teflon core, interlocked galvanized steel protective casing, AGA certified design.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Install natural gas piping in accordance with CAN1-B149.1-M80

3.1.2 Install branch piping for fuel gas and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment.
3.1.3 Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.

3.1.4 All pipe runs shall be laid out to avoid interference with other work.

3.1.5 Slope piping down in direction of flow to low points.
3.1.6 Use eccentric reducers at pipe size change installed to provide positive drainage.

3.1.7 Provide clearance for access for maintenance of equipment, valves and fittings.

3.1.8 Ream pipes, clean scale and dirt, inside and out.

3.1.9 Cap open ends during construction to prevent entry of foreign material.

3.1.10 Make connection to equipment with unions or flanges. Install piping to minimize pipe dismantling for equipment removal.

3.1.11 Provide vents for all gas piping shafts in accordance to code.

3.1.12 Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible.

3.1.13 Install union and shut-off valve on pressure piping at connections to equipment.

3.1.14 Provide cathodic protection on jackets for all buried steel pipes, as per local gas supply company.

3.1.15 Subcontractor installing buried gas piping shall be approved by the local gas supply company.

3.1.16 Coordinate with the local gas supply company and the General Contractor the location of gas meter and isolation valves.

3.2 PURGING

3.2.1 Purge after pressure test in accordance with applicable codes.

3.3 PIPE HANGERS, SUPPORTS AND ACCESSORIES

3.3.1 All piping shall be supported as per Section 15010 and Ontario Gas Code recommendations.

3.3.2 Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with red lead or zinc Chromate primer paint.
Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.

3.3.3 Floor, Wall and Ceiling Plates, Supports, Hangers:

3.3.4 Solid or split unplated cast iron.

3.3.5 All plates shall be provided with set screws.

3.4 PENETRATIONS

3.4.1 Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases. Completely fill and seal clearances between raceways and openings with the fire stopping materials.

3.4.2 Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant.

3.4.3 Piping shall conform to the following:

3.4.4 Entire fuel gas piping installation shall be in accordance with requirements of NFPA 54.

3.4.5 Install fuel gas piping with plugged drip pockets at low points.

3.5 TESTS

3.5.1 General: Test system either in its entirety or in sections.

3.5.2 Fuel Gas System: NFPA 54.

3.6 PAINTING

3.6.1 Paint the entire gas line yellow; where exposed to the outdoors, use outdoor-grade paint.
PART 1  GENERAL

1.1  GENERAL

1.1.1 Metallic rigid piping to connect HVAC equipment, including hot water/hot glycol

1.2  SUBMITTALS

1.2.1 Submit in accordance with Section 15010, shop drawings, product data, and samples for the following:

1.2.1.1 Pipe and equipment supports.
1.2.1.2 Pipe and tubing, with specification, class or type, and schedule.
1.2.1.3 Pipe fittings, including miscellaneous adapters and special fittings.
1.2.1.4 Flanges, gaskets and bolting.
1.2.1.5 Valves of all types.
1.2.1.6 Air separators
1.2.1.7 Expansion Tanks
1.2.1.8 Strainers.
1.2.1.9 Flexible connectors.
1.2.1.10 Pipe alignment guides.
1.2.1.11 Expansion joints.
1.2.1.12 Expansion compensators.
1.2.1.13 Gages.
   - Thermometers and test wells.
   - Pressure Gauges

PART 2  PRODUCTS

2.1  PIPE AND TUBING

2.1.1 2" diam and smaller:

2.1.1.1 Schedule 40. Continuous weld or electric resistance welded black carbon steel conforming to ASTM A53-84a Grade B, with threaded ends.

2.1.1.2 Type “L” hard drawn copper tubing conforming to ASTM B88. Type “L” soft annealed copper tubing may be used within convector enclosures.

2.1.2 2½” diam and larger:

2.1.2.1 Schedule 40. Continuous weld or electric resistance welded black carbon steel conforming to ASTM A53-84a Grade B, with bevelled ends.
2.1.2.2 Schedule 40. Continuous weld or electric resistance welded black carbon steel conforming to ASTM A53-84a Grade B, with grooved ends conforming to CSA B242-M.

2.2 FITTINGS FOR STEEL PIPE

2.2.1 65 mm (2½ inches) and Larger: Welded or flanged joints.

2.2.1.1 Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.

2.2.1.2 Welding flanges and bolting: ASME B16.5:

2.2.1.3 Weld neck or slip on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).

2.2.1.4 Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

2.2.2 50 mm (2 inches) and Smaller: Screwed or welded.

2.2.2.1 Butt welding: ASME B16.9 with same wall thickness as connecting piping.

2.2.2.2 Forged steel, socket welding or threaded: ASME B16.11.

2.2.2.3 Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.

2.2.2.4 Unions: ASME B16.39.

2.2.2.5 Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half couplings, ASME B16.11 may be used for drain, vent and gage connections.

2.3 FITTINGS FOR COPPER TUBING

2.3.1 Solder Joint:

2.3.1.1 Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
2.3.1.2 Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

2.3.2 Bronze Flanges and Flanged Fittings: ASME B16.24.

2.4 DIELECTRIC FITTINGS

2.4.1 Provide where copper tubing and ferrous metal pipe are joined.

2.4.2 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

2.4.3 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

2.4.4 Temperature Rating, 99 degrees C (210 degrees F).

2.5 SCREWED JOINTS

2.5.1 Pipe Thread: ANSI B1.20.

2.5.2 Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.6 VALVES

2.6.1 Asbestos packing is not acceptable.

2.6.2 All valves of the same type shall be products of a single manufacturer. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

2.6.3 Provide chain operators for valves 100 mm (4 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.

2.6.4 Standard of Acceptance: Crane, Jenkins, Toyo, Kitz.
2.6.5 Gate Valves:

2.6.5.1 50 mm (2 inches) and smaller: MSS SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.

2.6.5.2 65 mm (2½ inches) and larger: Flanged, outside screw and yoke.

2.6.5.3 MSS SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

2.6.6 Globe, Angle and Swing Check Valves:

2.6.6.1 50 mm (2 inches) and smaller: MSS SP 80, bronze, 1034 kPa (150 lb.) Globe and angle valves shall be union bonnet with metal plug type disc.

2.6.6.2 65 mm (2½ inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP 85 for globe valves and MSS SP 71 for check valves.

2.6.6.3 Non Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut off. Provide where check valves are shown in chilled water and hot water piping.

2.6.6.4 Body: Cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.

2.6.6.5 Seat, disc and spring: 18 8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

2.6.7 Butterfly Valves:

2.6.7.1 May be used in lieu of gate valves. Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation.

2.6.7.2 MSS SP 67, flange lug type (for end of line service) or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F).

2.6.7.3 Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65 45 12 electro-plated.

2.6.7.4 Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
2.6.7.5 Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.

2.6.7.6 Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.

2.6.7.7 Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain wheel operator.

2.6.8 Ball Valves:

2.6.8.1 May be used on piping 2” diam. and less.

2.6.8.2 Brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Screwed or solder connections. Provide stem extension to allow operation without interfering with pipe insulation.

2.6.9 Water Flow Balancing Valves

2.6.9.1 For flow regulation and shut off. Valves shall be line size rather than reduced to control valve size and be one of the following types.

2.6.9.2 Butterfly valve as specified herein with memory stop.

2.6.9.3 Eccentric plug valve: Iron body, bronze or nickel plated iron plug, bronze bearings, adjustable memory stop, operating lever, rated 861 kPa (125 psig) and 121 degrees C (250 degrees F).

2.6.10 Circuit Setter Valve

2.6.10.1 A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.

2.6.11 Automatic Balancing Control Valves

2.6.11.1 Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:
2.6.11.2 Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.

2.6.11.3 Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self cleaning piston/spring assembly that is easily removable for inspection or replacement.

2.6.11.4 Combination assemblies containing ball type shut off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.

2.6.11.5 Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

2.7 AIR SEPARATORS

2.7.1 Furnish and install as shown on the drawings an air separator with tangential inlet nozzles. The air separator shall be designed and constructed in accordance with Section VIII, Div 1 of the ASME Boiler and Pressure Vessel Code.

2.7.2 The unit shall be fitted with an NPT vent connection for connection to a compression tank or an air vent. An additional NPT tapping shall be provided on the bottom of the air separator to facilitate blow-down.

2.7.3 The air separator shall be equipped with a system strainer with a free area of not less than four (4) times the cross sectional area of the connecting piping. The strainer should be able to be removed for routine cleaning.

2.7.4 Models up to 3” (75 mm) diam. are to be equipped with stainless steel strainers. Larger models are to be equipped with carbon steel strainers.

2.7.5 Models up to 3” (75 mm) diam. shall be supplied with a cast iron body and NPT system connections, while larger models shall be supplied with a cast iron body and ANSI flanges. 8” to 24” models are to be supplied with a fabricated steel body and carbon steel ANSI flanges.

2.7.6 Standard of Acceptance: Armstrong model Vortex VAS.

2.8 EXPANSION TANKS

2.8.1 Furnish and install, as shown on the drawings an ASME pre-charged diaphragm expansion tank, stamped 125 psi (862 kPa) working pressure. Each tank will be supplied with a heavy duty butyl diaphragm. Tank shall be supplied with a ring base, lifting rings,
NPT system connection. An air charging valve connection (standard tire valve) shall be provided to facilitate adjusting pre-charge pressure to meet actual system conditions.

2.8.2 Standard of Acceptance: Armstrong AX-V series, Amtrol.

2.9 STRAINERS

2.9.1 Basket or Y Type. Tee type is acceptable for water service.

2.9.2 Screens: Bronze, monel metal or 18 8 stainless steel, free area not less than 2 1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations.

2.9.3 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations.

2.9.4 Suction Diffusers: Specified in section 15020.

2.10 EXPANSION JOINTS

2.10.1 Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.

2.10.2 Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.

2.10.3 Bellows Internally Pressurized Type:

2.10.3.1 Multiple corrugations of Type 304 or Type A240-321 stainless steel.
2.10.3.2 Internal stainless steel sleeve entire length of bellows.
2.10.3.3 External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
2.10.3.4 Welded ends.
2.10.3.5 Design shall conform to standards of EJMA and ASME B31.1.
2.10.3.6 External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
2.10.3.7 Integral external cover.

2.10.4 Bellows Externally Pressurized Type:

2.10.4.1 Multiple corrugations of Type 304 stainless steel.
2.10.4.2 Internal and external guide integral with joint.
2.10.4.3 Design for external pressurization of bellows to eliminate squirm.
2.10.4.4 Welded ends.
2.10.4.5 Conform to the standards of EJMA and ASME B31.1.
2.10.4.6 Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
2.10.4.7 Integral external cover and internal sleeve.

2.10.5 Expansion Compensators:

2.10.5.1 Corrugated bellows, externally pressurized, stainless steel or bronze.
2.10.5.2 Internal guides and anti torque devices.
2.10.5.3 Threaded ends.
2.10.5.4 External shroud.
2.10.5.5 Conform to standards of EJMA.

2.10.6 Expansion Joint Identification

2.10.6.1 Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

2.10.7 Guides

2.10.7.1 Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

2.11 GAGES, PRESSURE AND TEMPERATURE

2.11.1 For pressure and temperature gauges, refer to section 15010

2.12 PRESSURE/TEMPERATURE TEST PROVISIONS

2.12.1 Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

2.12.2 Provide one each of the following test items to the Owner:

2.12.3 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.

2.12.4 90 mm (3½ inch) diameter, one percent accuracy, compound gage-100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
2.12.5 0 - 104 degrees C (220 degrees F) pocket thermometer one half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.13 VACUUM AND AIR RELIEF VALVES

2.13.1 Vacuum and air relief valves shall be iron body with bronze trim, and stainless steel floats.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

3.1.2 Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.

3.1.3 Support piping securely.

3.1.4 Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

3.1.5 Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

3.1.6 Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take offs with 3 elbow swing joints where noted on the drawings.
3.1.7 Tee piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

3.1.8 Provide manual air vent at all piping system high points and drain valves at all low points.

3.1.9 Where glycol is used, direct all the discharge piping from vents, PRV and safety relief valves back into the glycol tank. Do not direct glycol discharges to the floor drains.

3.1.10 Connect piping to equipment as shown on the drawings. Install components furnished by others such as:

   3.1.10.1 Fluid treatment pot feeders and condenser water treatment systems.
   3.1.10.2 Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

3.1.11 Thermometer Wells: In pipes 65 mm (2 1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.

3.1.12 Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material.

3.1.13 Where copper piping is connected to steel piping, provide dielectric connections.

3.2 PIPE JOINTS

3.2.1 Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1.

3.2.2 Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

3.2.3 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

3.2.4 Solvent Welded Joints: As recommended by the manufacturer.

3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)

3.3.1 Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown.
3.3.2 Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.

3.3.3 Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.

3.3.4 Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

3.4 LEAK TESTING

3.4.1 Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Consultant. Tests may be either of those below, or a combination, as approved by the Owner.

3.4.2 An operating test at design pressure, and for hot systems, design maximum temperature. The design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head.

3.4.3 A hydrostatic test at 1.5 times design pressure.

3.5 FLUSHING AND CLEANING PIPING SYSTEMS

3.5.1 Water/Glycol Piping: Clean systems as recommended by the suppliers of chemicals specified.

3.5.2 Initial flushing:

3.5.2.1 Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/S (6 feet per second), if possible. Connect dead end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect downstream equipment. Supply and remove flushing water and drainage by various type hose,
temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Consultant.

3.5.3 Cleaning

3.5.3.1 Using products supplied by the chemical treatment manufacturer, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

3.5.4 Final Flushing

3.5.4.1 Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

3.6 WATER TREATMENT

3.6.1 Install water treatment equipment and provide water treatment system piping.

3.6.2 Close and fill system as soon as possible after final flushing to minimize corrosion.

3.6.3 Charge systems with chemicals specified in the chemical treatment specification section.
PART 1  GENERAL

1.1  GENERAL

1.1.1  This section of the specification shall be read in conjunction with and will be governed by the requirements outlined in section 15010.

1.1.2  Submit shop drawings in accordance with Section 15010.

1.1.3  Clearly indicate: Proposed routing, fittings, etc.

1.2  CERTIFICATION OF RATINGS

1.2.1  Catalogued or published ratings shall be those obtained from test carried out by the manufacturer or those ordered by him/her from an independent testing agency signifying adherence to codes and standards.

1.2.2  The materials used for the hot water boilers shall comply with all current regulations of the Authorities Having Jurisdiction, including TSSA.

PART 2  PRODUCTS

2.1  DOUBLE WALL CHIMNEY - SEALED

2.1.1  The venting system is to be installed only in accordance with the manufacturer’s instructions and with all applicable local, regional, and national codes.

2.1.2  The venting system shall be an air-insulated double-wall product designed for commercial applications. It shall be approved for use on individual or common vented ANSI Category I, II, III, and V Gas Burning Appliances and Direct Vent applications as approved by the appliance manufacturer.

2.1.3  The venting system shall be factory-built and tested and listed by Underwriters Laboratories to UL 1738 /ULC S636 for use with Listed natural gas or propane burning equipment that produce continuous flue-gas temperatures not above 550°F.

2.1.4  The system is to be installed and sealed per manufacturers’ instructions so all joints are gas tight, preventing leakage of products of combustion into a building.

2.1.5  The venting system shall be a double-wall product that consists of a flue-gas conduit fabricated from AL 29-4C® stainless steel, which is highly suited for use with high-efficiency gas burning equipment, which produce excessive amounts of condensation in the vent. The outer jacket of the system is constructed of type 430 stainless steel with a space of approximately 1” between the flue-gas conduit and the jacket.
2.1.6 All joints in the venting system are fastened with a new closure system that combines tapered ends with a mechanical closure system which consists of tabs and a locking band.

2.1.7 The locking band is tightened from a single location using a simple hand tool, pulling the two pieces together making a pressure tight assembly.

2.1.8 When installed on positive pressure or condensing applications, the joints must be sealed. Diameters 5" through 16" are manufactured with a factory adhered seal. Diameters 18" through 32" must use an approved sealant on the job site. This closure system is tested to be gas tight at two and one-half times the Listed pressure rating of 15" water column.

2.1.9 When properly installed the venting system may safely and securely be utilized in either interior or exterior installations. The system is capable of withstanding reasonable wind and incidental loads as required by UL standards.

2.1.10 When connected to gas-burning appliances with a maximum continuous flue-gas temperature of 550°F, 5" through 24" diameter venting can be fully enclosed vertically by combustible materials at 1" or greater clearance and 26"-32" diameter at 2" or greater clearance.

2.1.11 For horizontal applications refer to the manufacturer's Clearance Chart

2.1.12 The venting system is to be sized in accordance with appliance manufacturers' specifications, the most current edition of NFPA 211 Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances, the most current edition of NFPA 54 National Fuel Gas Code (ANSI Z223.1), ASHRAE recommendations, and all applicable local and regional codes.

2.1.13 All chimney supports, roof penetrations, terminations, appliance adapters, drain fittings and expansion joints required to install the chimney shall be included and shall be ULC listed products of the chimney manufacturer.

2.1.14 Accessories: cleanouts (bolted-gasketted type), expansion joints, roof flashing, radiation shield, storm collar, hanger and supports.

2.1.15 Standard of acceptance: Heat-Fab model Saf-T-Cl Plus, Selkirk- Metalbestos, Security Chimney

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Follow manufacturer’s and SMACNA installation recommendations for shop fabricated components.

3.1.2 Support chimneys at bottom, roof and intermediate levels as required. Install thimbles where penetrating roof and floor.

3.1.3 At shop drawings stage, the boiler manufacturers shall review on site with the contractor the final vents routing and lengths, and shall confirm the vent sizes. No allowances shall be made for the contractor and manufacturer’s representatives failure to examine the site condition and the final routing of the boilers venting.

3.1.4 The boiler manufacturer shall inspect the final venting arrangement and shall add barometric dampers if and where required for the optimal performance of the boiler plant. All costs for barometric dampers, start-up and adjustments shall be included in the project cost.

3.1.5 Install chimneys penetrating roofs as indicated, complete with flashings to suit installation.

3.1.6 Provide clean-outs at locations prescribed by the Authorities Having Jurisdiction and terminate outdoors with manufacturer-approved weather caps.

3.1.7 Provide drainage at low points and at all locations where water and/or condensate may accumulate; direct the vent drainage to the nearest floor drain, discharging through an acid neutralizer (supplied by the boiler manufacturer, installed by the contractor). Drain piping to be corrosion-proof and to include a min. 1” deep trap.